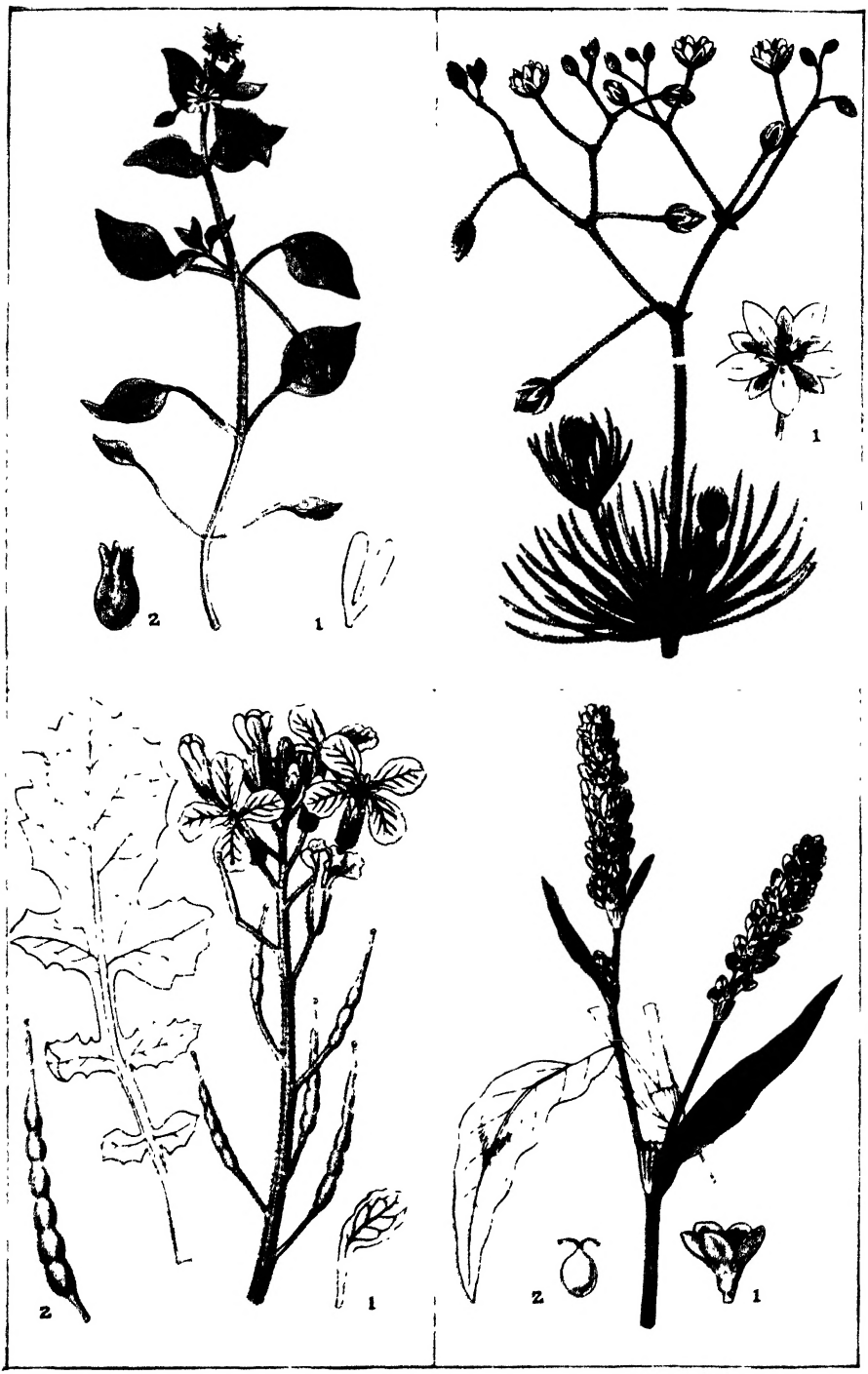
THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY



COMMON WEEDS OF ARABLE LAND

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY

BY THE MOST DISTINGUISHED AUTHORITIES AND SPECIALISTS UNDER THE EDITORSHIP OF

PROFESSOR SIR ROBERT PATRICK WRIGHT

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VOLUME XII

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WITH APPENDIX

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LIST OF PLATES

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VOLUME XII

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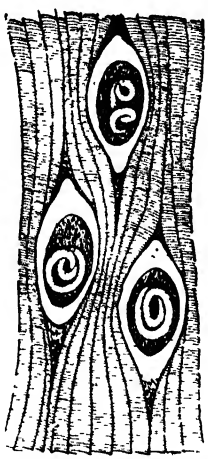
The classic series of articles on insects by the late John Curtis have been embodied in the work, revised by Professor F. V. Theobald and Mr. Cecil Warburton, M.A., and bear the initials of J. C. and F. V. T. or C. W.

In like manner the great botanical articles of the late Professor John Lindley, which, like Curtis's articles above-mentioned, were contributed to Morton's *Cyclopedia of Agriculture*, have, under Professor A. N. M'Alpine's revision, been embodied over the initials J. L. and A. N. M'A.

Trichina, a small nematode, parasitic in the intestine and muscles of various mammals. There is only one species, *Trichina spiralis*, which is often called *Trichinella spiralis*. The male is about 1·5 mm. in length and the female 3 to 4 mm. Rats are the commonest hosts, and as they often devour one another the parasite is readily transmitted. But a diseased rat may be eaten by a pig, a dog, or some other mammal, and a new host is thus infected. Man becomes infected by eating the insufficiently cooked flesh of a trichinosed pig. In all these cases what happens is that the young trichinæ, which lie encapsuled in the muscle fibres of the first host, are liberated in the stomach. They pass on to the duodenum or farther; they feed and grow, and in two or three days become sexually mature. The males seem to die after copulation. The females bore into the wall of the intestine, or through it into the mesentery and lymphatic glands. They produce minute embryos viviparously, about 1500 each, and these are carried by the lymph stream or blood stream. In about ten days they reach the striped-muscle fibres, within or between which they coil in a spiral and become surrounded by firm capsules, formed by inflamed connective tissue and becoming gradually more and more fatty and calcareous. The migration of the numerous embryos through the body causes inflammation and fever; the muscle fibres that are invaded undergo degeneration. A trichina cyst is microscopic, about 0·4 mm. in length by 0·25 mm. in breadth. There may be 12,000 in a gramme of pig's muscle. The imprisoned embryo may remain alive for many years—11 in the pig, 25 to 31 in man. Trichinæ have a cosmopolitan distribution, but trichinosis in man is more restricted, depending mainly on the degree to which the pork is cooked. In North Germany, where epidemics of trichinosis were formerly common, there has been a remarkable reduction—largely due to rigorous inspection—and *Trichina spiralis* is becoming much less common not only in man, but in pigs as well. See TRICHINOSIS. [J. A. T.]

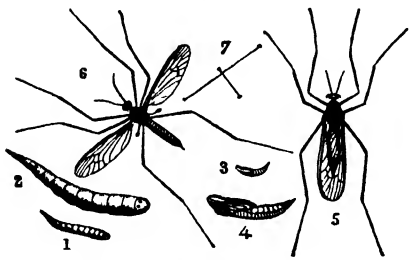


Trichina coiled within Cysts among Muscle Fibres (highly magnified)

Trichinosis is caused by small thread-shaped roundworms of the family Trichinidæ. Meat containing the embryos is the chief means of infection; slaughter-house rats on the Continent of Europe are much infested. The disease is thought to have been imported in the thirties of last century by Chinese pigs, at the time when crossing with Pekinese was tried. Where schincken and other uncooked or imperfectly cooked meats are partaken of, trichinosis is met with in man and carnivorous animals; but the disease has never been prevalent in this country, and swine have rarely been infested. There are several stages, embryo formation occurring seven days after reception in the intestine. The muscle trichinæ in a little envelope (encysted) are set free in twenty-four hours by the breaking up of their capsule; they become sexually mature in from one to two days, and give birth to living embryos in seven days from the time the supposed morsel of infected meat was eaten. The immigration of the embryos into the muscles lasts two or three weeks, boring through the intestine where the females deposit them, and wandering by preference into the crural muscles; but they are found in many parts of the body. It is supposed that they launch themselves into the blood stream, like the six-hooked embryos of tapeworm, and are prompted to anchor in the most suitable situations. Unless the host is eaten by another animal, the embryos undergo ultimate calcification, and are of no great consequence. The disease is seldom diagnosed during life, as the symptoms resemble those of intestinal catarrh and muscular rheumatism; and only when post-mortem examinations are made and the trichinæ discovered, is the pig-keeper suspicious of similar cases. No treatment is of use; only prevention by destroying rats and mice, and incinerating the carcasses of swine whose flesh is infested. See TRICHINA. [H. L.]

Trichocera hiemalis (De Geer) (the Winter Turnip Gnat).—When turnips become putrid, by being affected with anbury, this fly lays its eggs upon them; these produce maggots, which subsist upon the slimy matter. They are

shining, pale-yellow, cylindrical, tapering towards the head, and blunt at the tail. When they are nearly half an inch long, they change to dirty-coloured pupæ, and from these the gnats emerge in the winter and spring, flying in troops when the sun shines, even in frosty weather. The fly rests with its wings closed flat on the back. It is of an ash colour, with

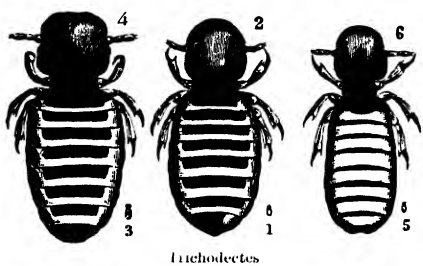


Trichocera hiemalis (Winter Turnip Gnat)

1, Maggot (natural size), 2, the same (magnified) 3, pupa (natural size); 4, pupa (magnified), 5, mature fly, resting (magnified), 6, mature fly, flying (magnified), 7, natural dimensions of mature fly

little black eyes, and two jointed bristle-like antennæ. On the thorax are four dusky stripes; body slender, obtuse in the male, pointed in the female; wings ample, very transparent, iridescent, with numerous nervures; balancers with dusky clubs; legs very long and slender; expanse, 6¾ lines [J. C.] [C. W.]

Trichodectes is a genus of the Mallophaga or biting lice. They do not suck the blood like



Trichodectes

1, 2, *T. bovis*, 3, 4, *T. equi*, 5, 6, *T. ovis* all natural size and magnified

the true lice (Pediculi), but live amongst the hair and fur, and feed upon them as well as upon the scurf. They infest the horse, ass, ox, sheep, deer, dog, cat, and other quadrupeds.

T. bovis, Linn. (the Ox Louse), is half a line long, and infests cattle. It is elliptical, pubescent, pale-tawny; head and trunk bright rust colour; third joint of antennæ the longest and tapering; two dusky spots on the forehead, and two angulated stripes on the back; body with six brown bands, lateral margins dark, as well as the tail.

T. equi, Linn. (the Horse Louse), is 1 line long, and paler in colour. The antennæ are thick and three-jointed; terminal joint the longest. It is abundant on horses and asses when at pasture.

T. latus, Nitz. (the Dog Louse), is ½ or ⅔ line long, and infests puppies. It is very broad and pale-tawny; the head and trunk rusty-yellow, with two black spots on the forehead, and two oblique black stripes on the sides of the head.

T. ovis, Linn. (the Sheep Louse), is about half a line long. It seems to be rare, but is sometimes found among the parasites from which sheep are freed by dipping. [J. C.] [C. W.]

Trident Moth (*Acronycta tridens*), a greyish-coloured moth with a wing expanse of about 1¼ in. The wings bear distinctive markings: a long black line extends from the centre to the base of the wings; a mark shaped like the Greek letter ψ occurs at the inner angle of the wings. The moth is widely distributed. The adult occurs from May to August, and the larvæ from August to October. The caterpillar is of a dull-grey colour, with a yellow line along the back, and having black protuberances on the fifth and twelfth segments. The pupa, which is a dull-grey colour, is found either in old trees or on the ground. The moth commonly occurs in woods and various garden trees. Arsenical washes kill them [R. H. L.]

Trifolium, the name of the genus of plants known as clovers (which see). The term is also employed by farmers in a restricted sense for *Trifolium incarnatum*, L., or Crimson Clover. The latter is sometimes called Italian clover on account of the fact that it was introduced from Italy first as an ornamental garden annual.

It is one of the most valuable fodder crops, being easy to cultivate, and in suitable districts producing a large bulk of nutritious green food in spring and early summer.

The plant has an erect stem, 18 to 24 in. high, with trifoliate leaves, the leaflets are roundish and covered with soft hairs, the stipules are blunt, often with a characteristic purple spot upon them. The flowers are a beautiful bright-crimson colour, borne in a terminal cylindrical head. The seeds are oval, larger than those of Red Clover, and in good samples pale-yellow with a rosy tinge.

Several varieties are cultivated which resemble each other in morphological characters but differ in their speed of growth and the time at which they are ready for use. Those of the most importance to the farmer are: (1) The *ordinary* Crimson Clover; (2) an *early* kind which, when sown at the same time as No. 1, is ready for cutting ten to fifteen days earlier; and (3) a *late* variety, which comes to maturity seven to eight days later than the ordinary sort. Some of the specially late varieties have white flowers.

Trifolium produces one crop only, which is generally consumed in a green state, being fed off on the land by sheep, or cut for soiling horses and cattle. It should be used as soon as the first flowers appear; if left too late it becomes woody, and the strong bristly hairs of the calyx are apt to prove injurious to stock. Many cases of death have occurred, especially among lambs, from the accumulation of balls of matted calyx hairs in the stomach of the animals. It is sometimes cut to hay, which when carefully handled is of high feeding value, and apparently preferred before red-clover hay by horses.

It is almost entirely grown as a catch crop before turnips, the seed being sown on the stubbles in autumn, and the crop utilized in the following May and early June. In specially favourable localities it is occasionally sown in February and March to provide green fodder after the autumn-sown crop has been consumed.

The crop succeeds best in the warm southern parts of England, and is adapted to most soils, except those which are very dry. It is somewhat tender, and the young plants should be well established before the autumn frosts. On this account the seed must be sown early, as soon as possible after harvest, August being perhaps the best month The only preparation of the soil needed is a slight harrowing of the stubbles, after which the seed may be sown broadcast at the rate of 18 to 20 lb. per acre. Without a firm seedbed the plant does not grow satisfactorily, the deep ploughing and pulverization of the soil which suits most crops being harmful to Trifolium; only on the stiffest soils is a slight ploughing useful for this crop.

Sulphate of potash and phosphatic manures are very beneficial to Trifolium; kainit applied to the young plants sometimes very seriously checks their growth [J. P.]

Trigonella, an annual leguminous subtropical plant, of robust habit, extensively grown in the East, Egypt, and Abyssinia. It is consumed as a fodder plant, the seeds are used in curries and as a condiment See FENUGREEK

Trinoton, a genus of Mallophaga or biting lice the species of which specially affect water fowls. They do not suck the blood, but feed upon the substance of the feathers. The best-known example is *T. luridum*, which is parasitic on the common duck and various species of ducks For other genera of the Mallophaga see LIPEURUS, TRICHODECTES, &c. [C W]

Tripe consists of the stomachs of bovines after having undergone special preparation According to the custom of the locality all the four or only three of the compartments of the stomach are used; occasionally the stomach of the sheep may also be used as tripe.

About 90 per cent of the tripe consumed in this country is home-produced; the other 10 per cent being imported from the United States of America, Canada, and Argentina, with occasionally a few consignments from Australia and New Zealand. Some of it arrives cooked and some uncooked, preserved by boron compounds; the consignments from Argentina arrive in a frozen condition.

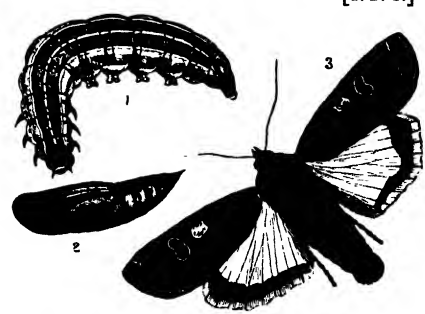
When the stomach is taken out of the carcass, its contents are emptied through an incision made by the butcher; the 'manifold' (omasum) and the 'reed' (abomasum) are detached from the 'paunch' (rumen) and the 'honeycomb' (reticulum); each portion is then dipped in water and hung up. In London the 'manifold', or 'feck' as it is called, is thrown away, or may be used as cat and dog food; while in Glasgow it is cleaned, and appears the whitest portion of the tripe. The spleen is detached from the paunch, as also any ragged or thick pieces of fat, prior to the removal of the organ to the tripery.

A large quantity of uncleaned tripe is sent to Lancashire, where perhaps most tripe is consumed. After arrival at the tripery, 'dressing' begins. The paunch is incised from the œsophageal opening downwards; it is then placed in a receptacle containing about three parts of boiling water to one of cold water, with a small portion of soda. After remaining in this water for about half an hour, it is withdrawn and turned inside out. The brown-coloured coating or mucous membrane is then scraped off; in London this is done by means of a knife, while in the Corporation tripery at Glasgow the greater part of it is done by machinery. The tripe, which now appears white, is well washed, and hung up to drain off the surplus water. The next part of the preparation consists in placing the tripe into a copper containing boiling water, and boiling it continuously for about three hours; it is then cooled down in three changes of clean water, the first of which should be slightly warm, the next just cool, and the last one cold. In some districts it is put into warm water after being boiled, and allowed to cool in this water, the idea being to retain as much moisture in the tripe as possible; thus it is soft and juicy. After being in the last water until quite cold, the tripe is placed on a drainer in order to get rid of the surplus water; the outside covering (peritoneum) is then stripped off, along with any loose fat, and the tripe is placed in clean cold water to await sale

It has been observed that as a general rule a tripe from an English-fed bovine is harder to scrape, but requires less boiling, than a tripe from an American-fed animal, which is whiter, and easier to scrape, but requires a little longer boiling.

An average tripe weighs about 8 to 10 lb., and the retail price varies from 3*d.* to 8*d.* per pound, according to quality and portion selected. An enterprising offal merchant has just had an analysis made of dark-coloured and light-coloured tripes, when it was found that the dark-coloured contained a much higher percentage of iron, the figures being white sample, 0·017 per cent of iron; dark sample, 0·047 per cent of iron.

[T. D. Y.]



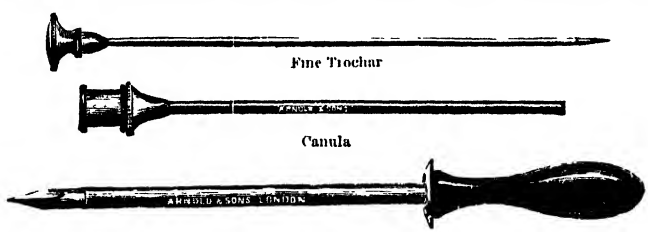
Triphæna pronuba (Great Yellow Underwing Moth)

Triphæna pronuba, Linn. (the Great Yellow Underwing Moth), is the parent of the largest surface grub, a caterpillar which does

great mischief to cabbages and turnip bulbs. It will feed also on the roots of grass, shepherd's-purse, and groundsel. It is pale-green, the back and sides inclining to rosy-brown dotted with black; there are three pale lines down the back, with seven black spots on the inside of the two outer ones (see fig. 1). It changes in a cell in the earth to a shining-brown chrysalis (fig. 2). The moths are abundant in hayfields in June and July. They rest with their wings flat on their back, and vary in colour from deep-brown to pale-tawny; on the upper wings are several irregular transverse lines, and in the centre an ear-shaped spot with a pale one; the under wings are bright-orange, with a black border (fig. 3). [J. C.] [C. W.]

Triticum, the botanical designation of that genus of the nat. ord. Gramineæ to which the cultivated wheats belong. See WHEAT.

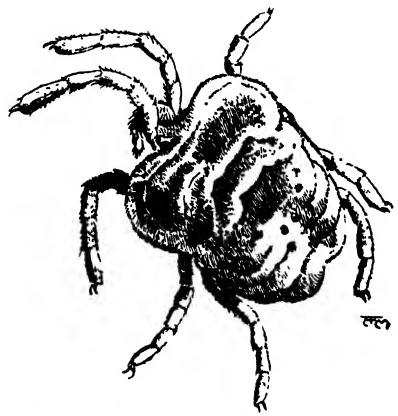
Trochar and Canula.—This is an instrument made in many sizes, and of great value to the doctor of animals, whether lay or professional. It consists of a steel cylinder, with bayonet or three-sided point in the larger sizes, but may be merely needle-pointed for the fine ones; and a handle of wood for convenience. The canula is a metal pipe fitting over it, but not covering the point, and having a collar at the other or handle end. Every stock-breeder should keep one of the larger sizes for blown cattle (see BLOWN), as the prompt use of this instrument is likely to save life. Whether for puncturing the rumen of cattle, or the large bowel in horses suffering from flatulent colic (in which a small instrument is employed), the procedure is the same. The site is first chosen, and then the trochar with its canula is driven through the tissues by a single effort (to avoid



Trochar and Canula (larger size)

lacerated tissues, which would occur with repeated stabs). When the point has reached its intended destination the trochar is withdrawn, leaving the canula in the animal, and thus giving vent to the intestinal or other gases. When the instrument is removed the wound is very small, because it was inserted when the tissues were distended, and now they have contracted. Any simple antiseptic dressing may be applied, but it is quite unusual for any trouble to follow in connection with the puncture. [H. L.]

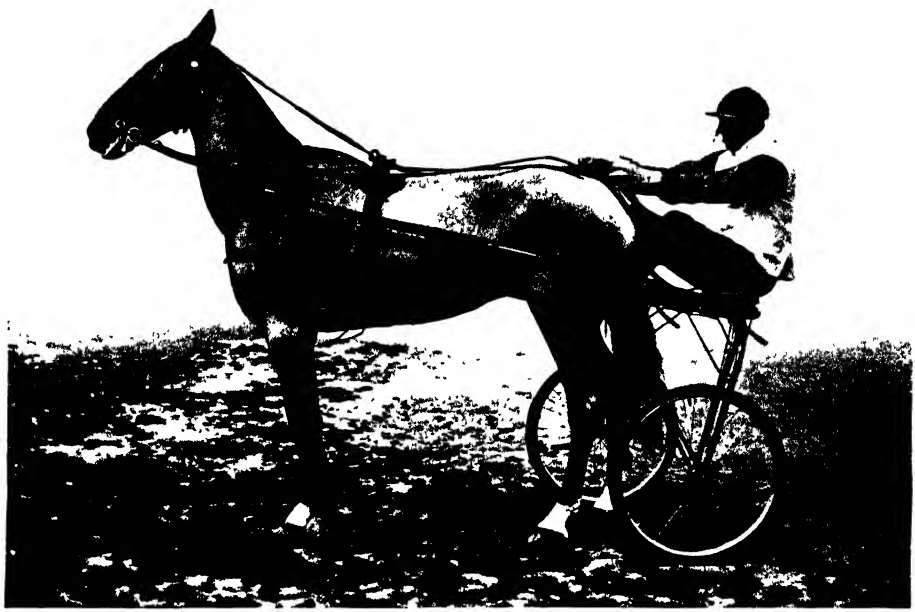
Trombidium holosericeum (Fab.), a large scarlet mite which is abundant in the spring in fields and gardens, and is accused in France of injuring the spikes of corn. It is somewhat quadrate, with a rostrum and two eyes; the body is divided by a transverse line, and it has eight legs. The six-legged young or larvæ of this and other species of Trombidium are the so-called 'harvest bugs'. They are para-


Harvest Bug (*Trombidium holosericeum*), greatly magnified (Natural size, about $\frac{1}{12}$ in long)

sitic in the skin of man and other mammals, and cause considerable irritation. [C. W.]

Tropæolum (nat. ord. Geraniaceæ), a genus comprising about forty species, natives of South America, and nearly all tender in Britain. *T. majus*, Indian Cress or Nasturtium of gardens, is a tall-growing annual plant (perennial in its native country) useful for covering arches, pillars, &c., easily obtained by sowing seed in the spring. There are several dwarf varieties useful for flower gardens and window boxes during summer. The leaves of this plant, which are round and peltate, are sometimes used as a salad, and the green seeds (fruits) when pickled may be eaten with cold meats. *T. aduncum* or *T. canariense* is the well-known canary creeper with pale-yellow deeply cut flowers. *T. speciosum* is the Flame Flower, a hardy, perennial, climbing plant with red flowers and thick, fleshy roots and underground stems, which flourishes in a cool, moist soil that is free from lime. *T. tuberosum* is a tender, perennial, climbing plant with orange and red flowers, and thick fleshy tubers, somewhat pear-shaped and of a yellow and reddish colour, used in Peru and Bolivia as an article of food. The tubers are boiled, then frozen, after which they are sopped in molasses and taken as refreshment during the heat of the day. *T. azureum*, *T. tricolorum*, and *T. pentaphyllum* are greenhouse climbing plants. It is interesting to note that the Tropæolums climb by means of their leaf-petioles. [A. H.]

Trotting Horses.—This designation has in more recent years come to be applied almost



TROTTING HORSE — CHAMPION DANDY BOY

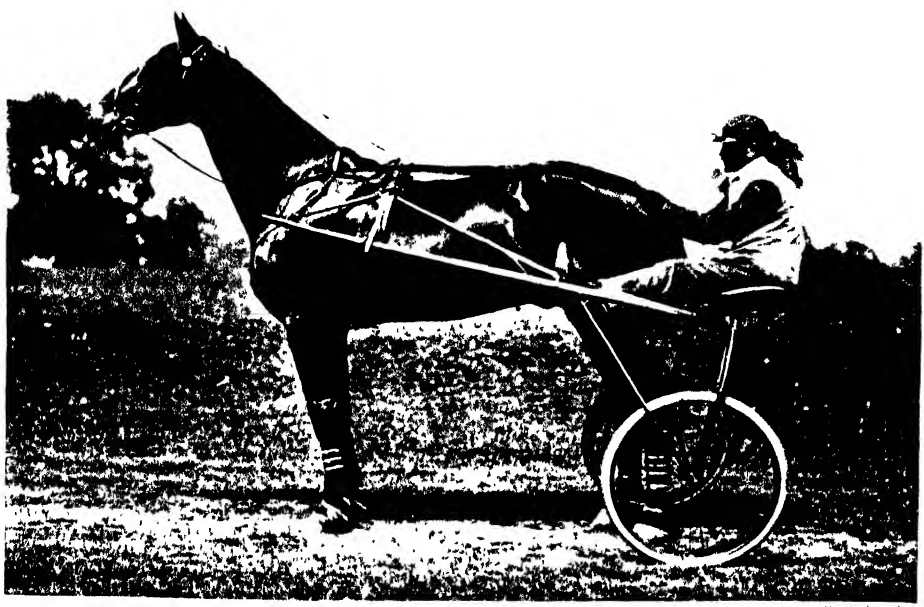


Photo W. A. Kouch

TROTTING HORSE — "JOE W."

exclusively to the American Trotter—a type of horse evolved in America in which excessive speed is found at the trotting gait. There are other types of the horse genus in which trotting action may be found; and the Hackney, or Norfolk Cob as he was originally called, acquired his first renown as a fast Roadster. The Orloff race of Russian horses was also noted for speed; and the best-known representative of this race in Scotland, the grey horse Messenger, owned by the late Mr. James Johnstone, Lochburn, Glasgow, was matched against Childe Harold, a notable American Trotting stallion, owned thirty years ago or more by Mr. John Hendrie, Kirkwood, Coatbridge. But the term is not now applied to any but American Trotting horses, to the breeding of which a vast amount of attention has been paid by wealthy gentlemen on the other side of the Atlantic. To such a pitch has speed at the trotting gait been brought, that in 1910 the record of a mile in a fraction less than 2 min. was made by a gelding named Uhlan, 1:58¼.

Two classes of these horses are recognized in the United States—Trotters and Pacers. The distinction is important The standard for the former is 2 30, that is, a mile in 2½ min., and all horses which attain to this are recorded as 'Standard-bred Trotters'. For a Pacer the standard is 2:25, which is an indication that greater speed can be got from the pacing gait than from the trotting gait. But the Pacer is not recognized as at all in the same grade as the Trotter; and although the two are recorded in the same Register, Wallace's Year Book, issued by the American Trotting Register Association, Chicago, Ill., they are not allowed to compete in the same classes, and are distinguished in the Register by the letter P being attached to the names of Pacers. The difference between the two gaits is noteworthy. A Pacer moves with side action, that is, he moves both fore and hind legs on the same side together, the hind leg following the fore leg. The Trotter, on the other hand, moves the left fore leg and the right hind leg simultaneously, and so maintains an even movement. But in order to do this his hind foot must be carried well forward on the outside of the fore foot on the same side of the animal. It is this which gives the American Trotter his tremendous force and speed. His hind legs are carried far in front of his fore legs, giving immense leverage, and moving the horse forward at a pace which is hardly realized by the onlooker, and is only to be verified by the most infallible stop-watch. The Pacer's movement is ungainly, and like that of the camel or retriever dog; but the fact that he can make better speed than the Trotter is due to important points in conformation, and the effect of particular methods of shoeing. By fastening the front and hind legs of one side together ('hobbling' as it is called), a Pacer can be forced to sustain the pacing gait; he cannot break into a trot, and he cannot gallop. A Pacer, on the other hand, can generally be made to trot if he has heavy shoes put on in front. Many of the early American Trotters broke down by having to wear such heavy shoes to keep them from pacing. These shoes sometimes weighed 1½ lb. each. The pacing instinct has been pretty well eliminated from most of the recognized trotting families, but occasionally a foal appears having this instinct, and in some stables such are promptly killed off. The lesson to be learned from this is that the American Trotter has been produced by a process of selection. A pacing horse moves from side to side, 'rolls' in fact; and instead of the regular tap, tap, tap, tap of the genuine Trotter, you hear from him something like this, 'tippety tap, tippety tap'—as it has been put, 'like a man walking in slippers without heels'.

Most of the so-called 'American Trotting horses' in Great Britain are Pacers, and in fact Harry Walker (an old American Pacer) was for years 'the champion Trotter of England'. The sport of trotting in this country is generally at a very low ebb, and only the least reputable of horse-owners are found identified with it. The owners of the best American Trotting horses in Great Britain never enter them for any of the so-called trotting matches organized in this country.

The modern American Trotter has a unique history. In a marked degree he is the product of a sport, in Nature, which was recognized as of value, and by a process of selection and line-breeding was eventually established as the supreme characteristic of a breed. The characteristic thus recognized in the progenitors of such amazing Trotters as the gelding Uhlan, 1 58¼ (in 1910), the stallions The Harvester, 2:02 (in 1910), and Crescens, 2:02½, and the mares Goldsmith Maid, 2:14 (in 1874), Nancy Hanks, 2:04 (in 1892), Maud S, 2:08¾ (in 1885), and Lou Dillon, 1 58½ (in 1903), was great speed at a trotting, as distinguished from a 'running' or galloping gait. The progenitor of all this was the English grey Thoroughbred stallion Messenger, which landed at Philadelphia in 1788. He had won eight out of thirteen races in England, and was imported into the United States to improve the 'running' horses of that country. He died of colic at Oyster Bay, Long Island, January 28, 1808, aged 28 years, 'and a volley of musketry was fired over his grave'. Among the most notable of his produce was Bishop's Hambletonian, a grey horse, foaled in 1803. 'He was distinguished for the elegance, speed, and endurance of his get, alike for the saddle, the harness, and the trotting course.' He sired two stallions which excelled as Trotters and got Trotters. These were Whalebone and Paul Pry; but his prime achievement as a breeder was the siring of a mare named One Eye, which in her turn was dam of the Charles Kent mare, and she was dam of the greatest fountain of speed in the American Trotter, an astonishing animal known to fame as Rysdyk's Hambletonian. Bishop's Hambletonian was 30 years old when he died. He stood 15·2 hands high, had plenty substance, and was used as a harness horse, showing great speed on the road, after he was 15 years old. In 1827 was foaled Harris's Hambletonian, a son of Bishop's Hambletonian and a spotted grey mare in Vermont which is reputed to have been a daughter of Messenger.

This Harris horse was 16 hands high, large and powerful, and weighed 1200 lb. 'He was a light stepper and difficult to pass on the road.' From this stock was descended Green Mountain Maid, 2:28½, and Lady Shannon, 2:28½.

The sire of Messenger was Mambrino, a grey horse bred by John Atkinson, Scholes, Leeds, Yorkshire. He was foaled in 1768, and made a name for himself on the Turf. He must have had the trotting instinct pretty strongly developed. A chestnut daughter of his named Mambrina, foaled in 1785, was imported into South Carolina when a two-year-old. From her is descended Grey Eagle, 'whose blood is a factor in a number of Trotters of merit'. In 1806 there was foaled in America another notable son of Messenger, named Mambrino. It is said he was never trained in harness, but was a natural trotter. This Mambrino, mated with a mare named Amazonia, 2.50, produced the first horse in the American Trotting Register, Abdallah I. He was bred on Long Island, and trotted at four years old a mile in 3.10. He was located in Long Island, New Jersey, Orange County, N.Y., and in 1840 he was in the famous blue-grass region of Kentucky. In Abdallah the trotting gift was strongly developed, and he bred many animals with records of about 2.40, which was considered exceptionally good work prior to 1861. Mention has been made of the Charles Kent mare. She was a bay, 15·3 hands high, foaled in 1834, 'with powerful stifles', and as a four-year-old trotted a mile under saddle in 2·41. Her sire was an English horse named Bellfounder, described as a 'Norfolk Trotter', standing 15 hands high, and imported to Boston, Mass., in 1822. This Charles Kent mare was mated in 1848 with Abdallah I, and the result, on May 5, 1849, was the greatest of all the foundation sires of the American Trotting race, Rysdyk's Hambletonian. He was foaled at Sugar Loaf, Cheetin, Orange Co., N.Y., and when five weeks old was purchased, along with his dam, by a cautious farmer named William M. Rysdyk, for the sum of £25 the pair. The colt grew into a powerful horse of 15·2, was bay in colour, with star and white hind ankles, and was named Hambletonian. One American writer says. 'His head was large and expressive, his neck rather short, his shoulders and quarters massive, and his legs broad and flat' He had a triple line of descent from the Thoroughbred Messenger, strengthened by the substance and trotting gift of the Norfolk Trotter Bellfounder, and the combination 'gave the greatest progenitor of harness speed the world has yet seen'.

One of the earliest produce of this great sire was Alexander's Abdallah, got by him when a two-year-old. Mr. David Bonner, one of the American experts in Trotting horses, who drove behind Rysdyk's Hambletonian, saw him do a mile in 2:48½, and was of opinion that he could have made a 2:30 record had he been trained. The horse was breeding from 1851 to 1872 inclusive, his terms rising from £5 a foal in 1852, to £100 a foal during the years 1866–72 inclusive. He died on March 27, 1876, being 27 years old. The best speed made by any of his produce was 2:17¼, the record of Dexter at Buffalo, August 14, 1867. Forty horses and mares sired by him surpassed the 2:30 standard, and his produce were even more distinguished as progenitors of speed than as its possessors.

Another notable source of Trotting fame was the horse Justin Morgan. This horse died in 1821, aged 32 years He was bred by a man named Justin Morgan at West Springfield, in Massachusetts, in 1789. His sire was True Briton, a saddle horse owned by a British officer, and said to have been stolen, during the War of Independence, from the British camp at White Plains, New York. In his veins was the blood of the Godolphin Arabian, and the dam of Justin Morgan is said to have had this blood also in her veins. Justin Morgan was a dark bay, standing about 14 hands high, and weighing 950 lb. He had black legs, mane, and tail, and was without white markings. His most notable characteristics abide in the American Trotter, and have imparted to him some of his most valuable properties. 'The back of Justin Morgan was very short, the shoulder blades and hip bones being very long and oblique, and the loins exceedingly broad and muscular. His body was rather long, round, and deep, close ribbed up' He was perfectly sound, and free from any kind of blemish. He was a very fast walker. What may have been his record in trotting is matter of dispute Some do not credit him with anything much better than 4 min, while others say he could trot a mile in 3 min. He did not lift his feet high, yet he never stumbled. He had a variegated career at the stud, passing through many hands, and it is obvious that contemporary opinion, while friendly to him, did not credit him with any extraordinary virtues In a form of contest now obsolete he excelled, namely, the pulling of heavy loads.

The influence of Justin Morgan in modern Trotting horses is due to three of his sons, Bulrush Morgan, Woodbury Morgan, and Sherman Morgan Each, until ten years old, did the ordinary work of the farm, and was inured to hardship. They were long livers. Sherman Morgan died at 27. His son, Black Hawk, died when 23 He was a prolific sire, and bred four standard Trotters whose influence counts to-day. These are Ethan Allen, 2·25½; Lancet, 2.27½; Belle of Saratoga, 2 29; and the Pacer, Young America, 2.23 Black Hawk is best remembered through Ethan Allen, whose daughter Pocahontas, foaled in 1859, out of a mare of the same name with record to wagon of 2:17½, made a record of 2:26¾ at Boston, and became the property of Mr. Robert Bonner at £8000. She trotted a mile in 2:17¾, but unhappily never produced a foal. The most renowned sire of this tribe is Daniel Lambert, got by Ethan Allen out of Fanny Cook, a chestnut mare by Abdallah I, the sire of Rysdyk's Hambletonian. General Knox, a black horse foaled in 1855, was a choice representative of this tribe; and the Morrill family are also of account in the modern development of the Trotter. Morgan Eagle, and Gold Dust, 2:43, are of Morgan descent. The best results in modern times stand to the

credit of the combination or blending of Morgan and Hambletonian blood.

A collateral line of descent traces from a horse named Mambrino Chief, foaled in New York State in 1844, and descended on the sire's side from Mambrino, the son of Messenger. From New York Mambrino Chief went to Kentucky, and there founded a family placed second only to the Hambletonians. He was a coarse horse with a big head, but bred marvels when mated with mares of refined breeding. One of his daughters was Lady Thorn, which trotted to a record of 2.18¼ at Providence, R.I., in 1869. She was dam of the famous General Washington. Out of the same mare as Lady Thorn was bred Mambrino Patchen, characterized as the most prepotent of the Mambrino Chief tribe. He was sound until he died, May 6, 1885, aged 22 A get of his named Mambrino King was pronounced 'the most handsome horse in the world'. Woodford Mambrino, 2.21, and Belmont were of this tribe. The former left but 86 foals; the latter lived to be 35, and to his race belong Palo Alto, 2 08¾ (in 1881), and Directium, 2:05¼ (in 1893). Some of the most celebrated members of the Trotting family were bred by blending the blood of Mambrino and that of Rysdyk's Hambletonian.

Pilot Jr., a grey horse, 15·2 hands high, foaled in 1844 in Kentucky, but of uncertain breeding, is one of the most successful sires of brood mares. He was probably descended from French Thoroughbreds. His sire Pilot was a black horse bred in Quebec. He died in Kentucky about 1853. The most renowned Trotter descended from Pilot Jr is Flora Temple, the first to break the 2·20 record His best-known son was Bayard, sire of Kitty Bayard, 2.12¼. A Thoroughbred daughter of Boston, named Sally Russell, was bred to Pilot Jr. in 1865, and produced a grey filly named Miss Russell. This is one of the greatest mares on record She had 18 foals, 17 of which came to maturity, and she died when thirty-two. One of her daughters was the famous Maud S. This great mare was foaled in 1874, and was got by Harold. She was the undisputed queen of the trotting turf for eleven years, but unfortunately never produced a foal Another daughter of Pilot Jr was Twilight, a Thoroughbred daughter of Lexington, which was a son of the already named Boston. Twilight was the dam of the sensational gelding Jay-Eye-See, which trotted to a record of 2·10, and paced to a record of 2·06¼. Waterwitch, another daughter of Pilot Jr., produced 19 foals that lived. Six of them had records better than 2:30, and one of the fastest, Scotland, 2:20½, was a gelding by the Thoroughbred stallion Bonnie Scotland.

Among subsidiary tribes which occasionally influence speed, one merits special mention. This is the 'Star' family, whose immediate founder was a horse named Seely's American Star, foaled in 1837 in New Jersey. He was not a beautiful horse, and his breeding is uncertain, but his female descendants have contributed much to the success of the Rysdyk Hambletonian sires. To American Star the Trotter is largely indebted for the unique action which enables him to send his hind legs so far ahead on the outside of his fore legs, giving him his tremendous leverage, and consequent speed. His sons and daughters, we are told, were low-headed and long-gaited, with wide action behind, and in this respect quite the reverse of the Morgan horses. The renowned gelding Dexter, foaled in 1858, was one of the outstanding results of combining his blood with that of Rysdyk's great epoch-making sire. Dexter defeated General Butler, Lady Thorn, and Goldsmith Maid. In 1867 he made a new world's record, doing the first mile in 2.20½ and the second in 2.17¼. He immediately thereafter became the property of Mr. Robert Bonner at £7000, and died in 1888 at the age of 30. One of the daughters of American Star was Nancy Whitman, dam of Robert M'Gregor, 2·17½, the sire of the great Crescens, 2 02¼, which until 1901 was the record.

Enormous prices have been paid for American Trotters. The extraordinary speed at which they have been driven in sulkies is in some measure due to the improved trotting courses, and the feather weights of the sulkies since the introduction of bicycle tyres. The physical structure of the horse has been studied, and moulded to produce speed. Every other property has been made subservient to speed, and the American Trotter is the most remarkable illustration of the power of man over Nature in moulding the animal creation. As the notes now given have shown, the breed is tough to a degree, sound, healthy, and longlived. Hence the influence it has wielded in improving the driving horses of the New World primarily, but in the long run of the whole world. Several high prices have been named. Others worth mentioning are these. Eleven colts by Electioneer, the most impressive of all the sons of Rysdyk's Hambletonian, at a sale held in New York in January, 1892, sold for an average of £1283 each. Mr Robert Bonner, prior to this date, had paid £8200 for Sunol, a mare with a 2 10½ record as a three-year-old. Mr. J Malcolm Forbes had paid £25,000 for Arion when he had made a 2 10¾ record to a high wheel, at Stockton, in 1881, as a two-year-old. £21,000 was paid for Axtell with a 2:12 three-year-old record, at Terre Haute, in October, 1899. It is said that Crescens, 2.02¼, cost the Russian Government £10,000.

The following table, abridged from The Trotting and the Pacing Horse in America, by Hamilton Busbey (Macmillan & Co., Ltd., London), to which we are indebted for many facts embodied in this article, illustrates the development of speed in the Trotting horse:—

Horse	Year	Time
Boston Blue, gelding	1818	3:00
Bull Calf, ,,	1830	2:47¾
Dutchman ,,	1839	2.32
Flora Temple, mare	1856	2:24½
Dexter, gelding	1867	2:17¼
Goldsmith Maid, mare	1874	2:14
Maud S, mare .	1884	2:09¼
Nancy Hanks, mare ...	1892	2:04
The Abbot, gelding	1900	2:03¼
Crescens, stallion	1901 ..	2:02¼
Lou Dillon, mare .	1903 ..	1:58½
Uhlan, gelding ..	1910	1:58¼

[A. M'N.]

Trout Fishing. See FISHING.

Trout Fishing (In Law).—The right to fish for trout belongs to the owner of the ground adjoining the stream or loch. In the case of a stream, and, in England, of a small pond, the rights of the proprietors would probably be divided by the middle line of the river or pond; but in the case of a large lake or loch, all the proprietors whose grounds abut on the water have, at all events in Scotland, the right to fish all over the loch, and not merely *ex adverso* of their land. In Scotland, trout fishing, unlike salmon fishing, is not a heritable right, but merely a personal privilege; and consequently a grant of trout fishing apart from the possession of land creates merely a personal obligation on the granter, and does not confer on the grantee a real right which could be maintained against a singular successor to the lands. The public has no right of fishing in non-tidal rivers whether navigable or not, and the right cannot be acquired by prescription. The fact that there is a right of way along the bank of a river or loch has been held in Scotland not to confer the right of fishing on the public. In England the right to take game and fish is an incident of the occupancy of land. In Scotland, on the other hand, it is an incident of the ownership of land. Consequently, in England, apart from express reservation, the right of fishing for trout will be in the tenant, whereas in Scotland, apart from agreement, the right is implicitly reserved to the landlord in all agricultural leases. In England, persons who by day are found fishing without leave in private waters, are liable to have their tackle taken from them, and if they submit to this they are not liable in further damage. In England, unlawful angling by night in water adjoining a dwelling-house entails a penalty of £5; if elsewhere, a penalty of £2; unlawfully taking fish in any other way than by angling is an indictable offence if in water adjoining a dwelling-house, and involves a penalty of £5 if elsewhere. Moreover, although an angler unlawfully fishing by day in private water cannot be arrested, one fishing by night may. Trout being wild by nature, there is not at common law any right of property in the fish, and apart from Statute no one can be charged with theft of them except, in England, where they are in a tank, net, or stew on private property. In Scotland the Act of 1607, which is still in force, made it an offence punishable as theft to take trout from any 'proper stank or loch', *i.e.* from any private fishpond or small artificial loch belonging entirely to one proprietor and used for the purpose of keeping fish therein. In England the catching of trout or char is prohibited between 1st October and 1st February, both dates inclusive, except as regards the Thames upper river, where the close time is between 10th September and 31st March. In Scotland the close time extends from the 15th day of September to the 28th day of February, both dates inclusive.

It is an offence to put lime or other noxious material into a pond or river, or to use dynamite or other explosives with intent to kill fish.

[D. B.]

Truffle, fungi usually found below ground, the true truffles belonging to the genus Tuber. *T. æstivum* is the species of most commercial importance. It has been known to attain a weight of 3 or 4 lb. The flesh is greenish or white when young, black veined with white when old. It is usually found in chalky soils (notably in Hampshire), and in proximity to beeches, though also under birches, oaks, and some other trees. Some species prefer oaks. Truffles are highly esteemed as condiments, though more so on the Continent than here. The practice of hunting for them with trained dogs or pigs has almost died out in this country, and attempts to propagate them artificially must be written down as a failure. Where, however, plantations of oaks and other suitable trees are made, some truffles will usually be found after about twelve years. [W. W.]

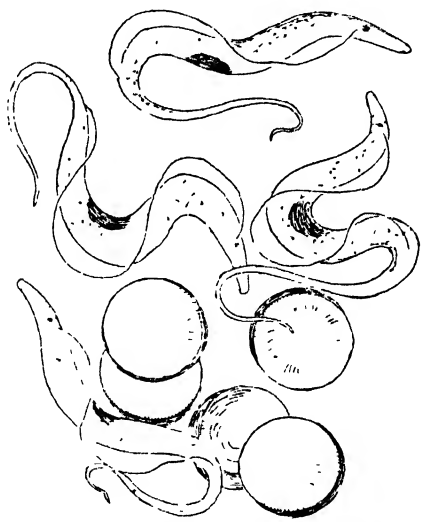
Trussing of Poultry.—Of the many methods of trussing, that known as the London style is most commonly in use. After the bird has been plucked and singed, it is placed breast downwards on the table with the legs facing the operator, and the digits of the wings are cut off. The skin at the back of the neck is held in the left hand and an incision is made, commencing about 1½ in. from where the neck joins the body and finishing at the shoulders, thus leaving a V-shaped piece of skin, the use of which will be seen after. The neck is then severed from the body at the junction, the whole is pushed forward, and the lower skin is cut, leaving about 4 in. attached to the body. By passing the thumb of the right hand under the crop, which adheres to the lower skin, the bird meanwhile being held in an upright position, this organ is loosened and can be cut out. Placing the bird back downwards and front forwards, the first finger of the right hand, palm upwards, is passed directly under the breast bone, and by moving gently to the left, keeping close to the body-wall until the backbone is reached, the heart and the right lung are detached; a second insertion of the finger and a similar movement to the right loosens the left lung. At this stage the only organ attached to the body-wall is the gizzard. The fowl is now held front downwards with the breast resting in the left hand, and a transverse cut is made about ¼ in. from the 'parson's nose' and to a depth of 1 in. The lower part of the intestine is then hooked by the first finger of the left hand and the vent cut off. Placing the bird on its back, the first finger of the right hand is inserted and passed between the gizzard and the breast. Two fingers are put in, and a firm grip taken of the gizzard. On pulling out, the whole contents of the body should follow. If this has been done properly there will be no need to wash out the fowl, as it will be found to be quite clean. The merrythought or wishing bone is next taken out. This is done by scraping away the flesh on its upper surface, cutting through the connections between it and the shoulder, and then, by putting the knife beneath, with an upward movement the bone will cut its own way from the flesh which embeds its single end. The V-shaped piece of skin is

wrapped over the stump of the neck, and the larger piece is folded over this and allowed to lie along the back. The fowl is now ready for the final work of tying up. For preference this is done by means of a trussing-needle and string. The bird is placed back downwards on the table, and the legs, taken by the left hand, are pulled as far forward as possible, but at the same time pressed downwards so that the thighs rest on the table. The needle is passed through the body at the junction of the thigh and the 'drumstick', continuing through the two bones of the forearm and out through the bones of the hand, the same being done with the second wing but in reverse order. The two ends of the string which are together are tied as tightly as possible. The bird is further held in the left hand, the needle is put through the fat at the root of the 'parson's nose', wrapped once round that appendage, taken over the leg through the gristle at the end of the breast bone, over the second leg, and the two ends tied. To finish, the toes can be cut off, this usually being done with white-legged, five toed birds, or the legs can be severed about 1 in. below the hocks. [W Br]

Trypanosomes, microscopic flagellate parasites which give rise to deadly diseases in man and animals. Unlike bacteria, they are of animal nature. Trypanosomes are unicellular blood parasites of extraordinary activity, wriggling about with wormlike movements among the corpuscles or rotating in one spot. The minute animal is colourless, elongated, often curved on itself like a screw, and a long complex flagellum projects in front. The flagellum is usually expanded into an undulating membrane which extends down one side of the cell. Stained preparations show a delicate external pellicle, a nucleus in the middle, a firm axial filament extending up the flagellum, along the margin of the undulatory membrane, and arising from a strongly refractive little body known as the blepharoplast. In many cases there are distinct longitudinal fibres running through the Trypanosome, which are interpreted as contractile and called myonemes. Trypanosomes multiply by dividing longitudinally into two (nucleus, blepharoplast, undulatory membrane, and flagellum being all equally divided), or by dividing up into many daughter cells. There has not as yet been any satisfactory evidence of sexual forms or of conjugation. A very instructive and important fact is that Trypanosomes are extremely plastic; a particular species may change its appearance and characters according to its surroundings within the same host or in different hosts.

Many different diseases are due to Trypanosomes. (1) The terrible sleeping sickness of natives in tropical Africa, which has spread of recent years along the caravan routes, is due to *Trypanosoma gambiense*, and one of the Tsetse flies (*Glossina palpalis*) is the intermediate host by which the micro-organism is disseminated. (2) The deadly Nagana disease, widespread in Africa south of the Sahara, which affects horses and cattle and a number of other animals, is due to *Trypanosoma brucei*, and another of the Tsetse flies (*Glossina morsitans*) is the intermediate host. (3) The Surra disease of horses, mules, &c., in India and other parts of tropical Asia is due to *Trypanosoma evansi*, and the disseminator seems to be one of the breeze flies or Tabanidæ. (4) Dourine, which affects horses in Europe, North Africa, and Western Asia, is due to *Trypanosoma equiperdum*. (5) Mal de Caderas, a horse disease which has spread from Argentina to the Amazon, is due to *Trypanosoma equinum*. (6) The gall sickness of cattle common in South Africa is due to *Trypanosoma theileri*. Besides these there are many others.

Trypanosomes occur chiefly in the blood of their vertebrate hosts, but they may also occur in other parts of the body, such as spleen, bone-



Trypanosoma Brucei, the parasite of Nagana, magnified about 2000 times. The round bodies are blood corpuscles, magnified 1300 times.

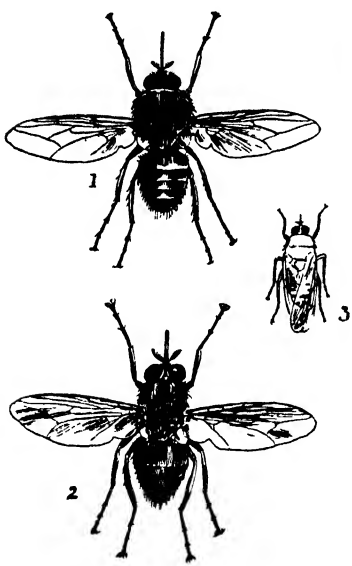
marrow, liver, lymphatic glands, the conjunctival sac of the eye, the mucous membrane of the genital ducts, or in swellings on the skin. They pass from host to host either by contact, as in the case of dourine, or by the agency of a blood-sucking intermediate host. Besides the Tsetse flies which spread sleeping sickness and Nagana, there are many other intermediate hosts in other cases, thus lice and fleas carry Trypanosomes from rat to rat, and mosquitoes from owl to owl. In the case of Surra, Mal de Caderas, and the like, the agents seem to be flies like Tabanus and Stomoxys. Within the blood-sucking intermediate hosts the Trypanosome often assume a new form, which is probably the original one, for there is much to be said in support of the view that the Trypanosomes were originally insect parasites that have been secondarily transferred to vertebrates. It must also be noted that many Trypanosomes may be present in the blood of an animal without doing any noticeable harm—the host species having

become in the course of ages immune to that particular kind of parasite. But the transference of the Trypanosome in question to a new host may start an epidemic.

Among the clinical symptoms of Trypanosomic diseases may be noted—anæmia, fever, emaciation, weakness, swellings on the skin, accumulation of exudations in cavities of the body, increase in the size of spleen and lymphatic glands, paralysis, and cerebral disorders. The two chief practical problems are. (1) to restrict the spread of the diseases, *e.g* by getting rid of the intermediate hosts and by strict sanitary precautions, and (2) to discover by modern methods some antagonist of the Trypanosome in its deathful work within the body of the infected organism, and some means of bringing about artificial immunization.

[J. A. T.]

Tsetse Fly.—*Glossina morsitans*, a fly (Diptera) of the house-fly type (fam. Muscidæ), is



1, Tsetse Fly (*Glossina morsitans*), female, × 2; 2, *Glossina palpalis*, male, × 2. 3, Normal position of closed wings when fly is at rest

the well-known Tsetse fly of South Africa. It is greatly dreaded on account of the fatal effects of its bite on horses. To man himself it is innocuous, nor does it kill horses by reason of any poison that it secretes, but it serves as a carrier of a blood parasite (Trypanosoma) from animal to animal, and if it sucks the blood of an infected animal its next victim, if subject to the disease, is infected with the parasites. It thus acts in somewhat the same way as the Anopheles mosquito has been shown to do in the case of malaria. In appearance the Tsetse fly is about the size of the common Blow-fly but brown, with yellowish stripes across the abdomen. In life-history, however, it more resembles the English Forest-fly, for instead of depositing eggs it produces fully formed maggots which immediately turn to pupæ. The fly occurs in fairly well-defined regions, into which it is, at present, fatal to introduce horses. Its extermination is no simple matter, but the eradication of the disease in the animals it attacks would render its bite harmless. In England malaria has been eradicated by drainage and medical treatment, and though the Anopheles is still found in this country its bite is no longer serious. As to the action of tsetse flies in spreading trypanosome diseases, see TRYPANOSOMES. [C. W.]

Tuberculin Test.—Tuberculin is a glycerine extract of pure cultivations of the tubercle bacilli filtered through porcelain to deprive it of the organisms themselves. In the form employed for injection under the skin of bovines, it is diluted with ten times its bulk of a watery solution of carbolic acid of the strength of ½ per cent. It produces a mild febrile attack sometimes called reaction fever. It is important to ascertain the temperature of the animal to be tested on at least two occasions previous to inoculation, or the results may be vitiated. A rise of temperature usually takes place between the twelfth and fifteenth hours, but the clinical thermometer should be used at the ninth, twelfth, fifteenth, and eighteenth hours, and the temperature recorded. A slight rise only may be inconclusive, but an increase of two or three degrees will almost certainly indicate the disease. The neck is the most convenient part in which to insert the hypodermic needle, but the loose skin behind the elbow will do as well. Tuberculin testing should be left to the professional man, as it requires experience to read the symptoms correctly, and his certificate alone will be of value. It should be understood that tuberculin is not entirely trustworthy, yet is of great diagnostic value. Many wasters that have died after giving no reaction to tuberculin have been assumed to have suffered from tuberculosis, without post-mortem examination, but were the victims of Johne's disease, from which it can only be distinguished in life by an increase of temperature following on injection of tuberculin. Discredit has therefore been cast upon the preparation because it did not act. See TUBERCULOSIS. [H. L.]

Tuberculosis is a contagious and generally a very chronic disease, affecting most species of warm-blooded animals as well as man. In mankind it is known by everybody as consumption, or lung disease, and its most conspicuous form is indeed a chronic inflammation and ulceration of the lung; but it is a very multiform disease, attacking nearly all organs in the body. In the beginning it is characterized by the formation of small white nodules or tubercles, but the morbid deposits assume often a more diffuse character.

Of domestic animals, tuberculosis is most common in cattle, swine, and poultry, less frequent in dogs, cats, and horses, and still more rarely it occurs in sheep and goats. It is a rare disease in wild animals, except when they are kept in captivity. In zoological gardens it is

rather common in monkeys and in many species of birds, and there it also sometimes attacks wild carnivores as well as other mammals. For experimental studies in laboratories, guinea pigs are most frequently used, less commonly rabbits, to both of which species tuberculosis is easily transmitted.

Nature of Disease.—Although the idea of the contagiousness of tuberculosis had for long been familiar, it was formerly as a rule considered the result of a diathesis, a bad condition of the body chiefly depending on heredity and on all kinds of weakening influences. The French physician Villemin was the first who, in 1865, proved its inoculability, and in 1882 the German bacteriologist Robert Koch found its real cause. By means of a specific coloration he demonstrated in all tuberculous deposits a small bacillus, which he was able to cultivate, and by inoculating it in many different species of animals he produced the disease. This bacillus is a slender, rod-shaped organism from 1·5 to 5 μ in length, and from 0·2 to 0·5 μ broad It is easily distinguished from most other bacteria by its acid-fast character, that is, its faculty to retain the colour when treated with a strong acid solution.

Since this discovery by Koch, we know for certain that tuberculosis is a *purely contagious disease*, whose real cause is the entrance into the body of the tubercle bacillus. Tuberculosis cannot come into existence without this occurrence, any more than can wheat without the sowing of the seed; but just as the condition of the soil has a great influence upon the development of the seed, so may the condition of the animal's body be more or less favourable to the growth of the bacillus and to the development of the morbid changes which we call tuberculosis Some species of animals are more resistant against the bacillus than others, and so are some individuals within the same species; even the same individual may in different periods of his life be more or less resistant. Very young animals are, for instance, less resistant than older, and all kinds of weakening influences, such as bad nutrition, parturition, or acute or chronic diseases, may diminish the resistance and make the animal's body a better soil for the tuberculous germs.

Tubercle bacilli.—Tubercle bacilli can be cultivated in laboratories under favourable conditions; but outside of the animal body they are not able to propagate, because they require for their growth a constant temperature of about 37° to 38° C., and because they grow rather slowly and would consequently be overgrown by common bacteria. Therefore we are justified in saying that every tubercle bacillus we find in nature is simply a germ discharged from a tuberculous animal or human being. Such discharge generally exists when tuberculosis attacks organs which communicate with the outer or inner surface of the body, and when the tuberculous deposits are broken down or ulcerated (so-called open tuberculosis), such as is often the case in the lungs, in the intestinal canal, or in the urogenital organs. In human beings, sputum is the most important carrier of tubercle bacilli; in cattle most bacilli from the diseased lungs are discharged with the fæces, because the cow swallows most of its sputum. A very great number of the bacilli are to be found in the discharge from a tuberculous uterus and in the milk from a tuberculous udder; and if the kidneys are diseased, bacilli may be found in the urine.

Tubercle bacilli are rather resistant, so that they may remain living outside the body for a very long time, half a year or more, especially when they are not exposed to sunlight. Hence it is that not only *living together* with an animal or human being affected by open tuberculosis exposes a healthy individual to contagion; the localities where such an individual has lived may also remain dangerous for a certain time. Further, animal products, such as milk, dairy products, and meat, can be carriers of tubercle bacilli

Mode of Infection.—Tubercle bacilli may enter the body in different ways: (1) by inhalation of dried and pulverized sputum or other discharge, or of the small drops of phlegm discharged in coughing; (2) by the alimentary canal when the food itself contains the bacilli or when they accidentally have been scattered upon it. Scientists disagree as to which of these ways plays the more important part, but from a practical point of view this dispute is of no great consequence Both ways exist, and the close association with individuals with 'open tuberculosis' is equally dangerous, whether the bacilli are inhaled, or admitted through the mouth after having fallen on the food or drink.

The bacilli may also (3) be inoculated into wounds, or (4) enter into the sexual organs during coition. In some cases they are (5) transmitted from the mother to the fœtus through the placenta (congenital tuberculosis). This happens comparatively rarely The conditions for the infection of the fœtus are, either that there is tuberculosis in the uterus itself or that tubercle bacilli circulate in the blood of the mother, and this happens only in very exceptional cases, unless the mother suffers from tuberculosis in a very advanced and generalized state In regions where tuberculosis is of very frequent occurrence we find not more than 0·3 to 1 per cent of the new-born calves affected with congenital tuberculosis.

Development of disease.—When the tubercle bacillus has entered the body it propagates, and it irritates the cells and calls forth a specific inflammation which produces a very small nodule around the primarily affected cells in which the bacilli are picked up The lymph stream carries the brood of the bacilli to the surrounding tissue and new small nodules are formed. The lymph ducts carry the bacilli to the lymph glands that serve as a filter, in which they are often retained for a time We therefore find the tuberculous nodules very often, especially in the lymph glands, and these are in many cases the primary seat of the disease, evidently because the bacilli soon after their entrance into the body pass into the lymph ducts and are carried to the glands. When the bacilli are picked up with the food we do not as a rule find nodules in the mucous

membrane, but in the lymph glands around the throat or in the mesentery, and when the bacilli are inhaled we often find the first nodules in the bronchial or mediastinal glands and not in the lungs.

Thus tuberculosis always begins as a *local disease*, but it generally spreads more and more from time to time. From the first affected gland it may go to the next, and from the first nodule in any organ it spreads to a greater part of the same or to its covering membrane. The tuberculous deposits are very much inclined to decay and to form abscesses or ulcerations, and the discharge from such an ulceration will flow over the mucous membrane and infect another part of it. By the growth of the nodules and their degeneration the bacilli may invade the bloodvessels and with the blood be carried to the remotest parts of the body, *i.e.* to the bones and articulations, to the brain, the kidney, or the spleen. Thus tuberculosis may injure the body in two different ways- either by destroying some important organs as the lungs or the liver, or by affecting many different organs. In both cases are also formed toxines which may produce fever and injure the tissues.

On the other hand, tuberculosis may for a very long period remain localized to very restricted parts of the body, and there is no doubt that the disease is often healed in that the nodules are incapsulated and calcificated and the bacilli finally die. It is well known, however, that the bacilli may also remain living many years in such old deposits, and we often see a tuberculous deposit remain occult for years and then under unfavourable circumstances (acute diseases, parturition, &c.) suddenly flare up

Lesions.—These differ very much, according to the seat and the development of the disease. In the main we find deposits in different organs of whitish nodules varying in size from being hardly visible, to a pea, a hazel nut, or a hen's egg, or in other cases a more diffuse infiltration of a white or yellowish colour. Nodules of the size of a millet seed are called miliary tubercles. The smallest nodules are usually composed of a mass of large cells, so-called epithelioid cells and giant cells, surrounded by smaller lymphoid cells. The tuberculous tissue has a very poor vascularity, and its central part, therefore (and probably also on account of toxines), generally after some time will become necrosed and be altered to a caseous substance usually containing particles of lime salts. Sometimes this substance is dry, sometimes soft, and it may be quite emolliated or even purulent. Thus tubercular deposits may be partly converted into a kind of abscess, whose contents, however, look more flocculent and lumpy than that of a common abscess. The surrounding tissue is usually the seat of a chronic inflammation leading to the formation of a fibrous tissue. The deposit of small tubercle nodules on the serous membranes covering one of the cavities of the body may, on the other hand, be followed by exudation of a mostly serous nature. Thus the lesions may differ extremely, and in former times, before the bacillus was known, pathologists often were unable to diagnose the nature of a morbid condition that we now easily recognize as tuberculosis.

Without going into details we shall shortly describe some of the most characteristic features of the *post-mortem lesions* in some frequently affected organs. The lymph glands may contain dry or soft nodules of different size, or the whole gland may be filled with a tuberculous matter of different consistence. The glands are often very much enlarged, and may, for example in cattle, be as big as the head of a child, or even bigger. In the *lungs* the tubercular lesions may have the character of small or large nodules, but frequently they may rather be described as the result of chronic caseous inflammation of greater or less extent. Nodules as well as pneumonic infiltrations may be solid and more or less caseous or calcified, but they are often partly softened and converted into cavities, the so-called cavernæ discharging into the bronchi, whose mucous membrane may be ulcerated Chronic inflammation of the bronchi, that are filled with thick granular or cheesy matter and greatly distended, is also a very common lesion Around the tubercular deposits is usually formed an indurated connective tissue, and the diseased parts of the lungs are often adherent to the ribs or diaphragm by means of such new-formed tissue

On the *serous membranes* covering the lungs and chest wall, the heart or the abdominal organs (peritoneum), the tubercular deposits may be small nodules; but more frequently, especially in cattle, we find these membranes more or less covered with large solid nodules or warthike masses, often connected to the membrane by means of a reddish connective tissue, which sometimes forms a short pedicel. Young nodules have a grey-white aspect on the cut surface, older ones usually are completely calcified. They are often very great, of the size of a walnut or a hen's egg, and they may be so numerous that they form masses of a thickness of several inches and of a very great extent. In such masses the single nodules may be connected to each other by means of delicate fibres, but they may also be completely confluent. This peculiar lesion is from old time called *pearly disease* (or *grape disease*), and it was formerly usually considered a specific disease, different from the tuberculous lung disease Although tuberculosis in the lung is often combined with pearly disease, it really frequently happens that one of these forms is much more developed than the other, or one of them exists alone.

Tubercles on the *mucous membranes* of the trachea, bronchi, the bowels, or the uterus are usually soon converted into roundish ulcers with elevated yellowish borders and a depressed yellowish caseous centre. In the uterus isolated ulcers are, however, not frequently seen, in most cases the mucosa is here infiltrated and ulcerated over the whole. In cattle, tuberculosis in the larynx frequently appears in the form of a great tumour without ulceration that may nearly plug up the cavity. Intestinal ulcers are not uncommon in cattle, but very rare in swine; in fowls they are (together with nodules in the liver, spleen, and femur) the

most important lesion, and in these animals the ulcers have usually a peculiar aspect in that the intestinal wall under the ulcers is very thick and produces a small tumour protruding on the outside of the intestinal canal.

The liver, the spleen, and the kidneys may be the seat of nodules of the most varying size. In cattle, tubercles are usually small in the spleen, but in swine and horses we frequently find very large tumours in this organ.

In the brain and spinal cord, tuberculosis has usually the character of miliary nodules in the meningeal membranes surrounded by an exudate or by a new-formed inflammatory tissue, but we may also find larger caseous nodules in the interior of the brain or of the *medulla spinalis*.

Of the *udder*, usually only one of the quarters (mostly a posterior one) is affected. It may contain a number of small or great nodules, but more frequently the disease has the character of a very extended chronic tubercular inflammation. On a cut surface we find in the first affected parts (mostly the outer parts) all lobules hard, caseous, or even calcified, while in the parts where the disease is more recent the udder tissue is more or less supplanted by a light-reddish new-formed tissue in which there may be seen an incipient calcification along the milk canals. The lymphatic gland above the udder is much enlarged and filled up with tubercular masses.

In the *bones*, tubercular nodules are inclined to softening, and tubercles in the spongious tissue close to articulations may sometimes break down the cartilages and open the joints. In these the serous membrane as well as the surrounding tissue may be the seat of nodules of different size. Bones and joints are much more frequently affected in swine than in other mammals.

In the muscular tissue, tubercles are of extremely rare occurrence.

Symptoms.—In the beginning there will as a rule be no symptoms at all. The deposit of some small tubercles in one or in a few lymphatic glands cannot affect the animal in a visible way; and when we remember that the lesions very frequently remain a very long time confined to the first infected organ, which may be far away from the surface of the body, we easily understand that *tuberculosis may remain an absolutely occult disease for years*. That is the reason why statistics from slaughter-houses and from tuberculin tests correspond so little to the opinion of the cattle-owner regarding the health conditions of his animals. He cannot understand the assertion that a very great number of cattle of the most healthy aspect and not exhibiting the slightest symptom of illness nevertheless are affected with this disease of bad repute. It is not until the disease has progressed considerably, and mostly after a rather long occult period, that it gives *clinical symptoms*. These, of course, vary very much, according to the affected organs. In *tuberculosis of the lungs*, *coughing* is the most noticeable symptom. The cough is mostly dry, short, and hoarse, but may later on become prolonged, convulsive, and very troublesome to the animal. It is more frequent in the morning at feeding time and after movement. There may be a little slimy and purulent discharge from the nose, but that is frequently absent. When much of the lung tissue is diseased the breathing is laboured. Auscultation reveals, especially after quick movement, abnormal sounds in the lungs, especially sibilant, sonorous, and raucous. A dull sound is often detected on percussion.

When the *lymphatic glands* in the breast cavity are much enlarged they may press upon the œsophagus and prevent the escape of gas from the stomach; in such case the cow shows chronic or habitual bloating. Great enlargement of the glands above the throat often makes breathing difficult and noisy, and may also interfere with the swallowing.

In cases of *brain and meningeal tuberculosis* the animal will be unsteady in its movements, often carry the head in an unusual position, and it is sometimes attacked with convulsions. Such cases are inclined to advance rapidly, and terminate in death following coma.

If the *uterus* is affected there will be a discharge from the vagina of a flocculent or clotted, odourless, purulent matter, and the uterus, and usually the oviducts, are found enlarged and hard when explored by the rectum. Enlargements and partial ulceration of the Gartner canals may be observed in the vagina. For the veterinarian the *rectal exploration* is in many cases a very valuable method for the diagnosis, as in this way he is not only able to find tubercular lesions in the genital organs, but also in the left kidney, in the lymphatic glands, especially the mesenteric, and to find pearly disease in the peritoneum. Without rectal exploration it is usually very difficult to affirm the existence of 'grapes' in the abdomen. *Pearly nodules* on the pleura may give a friction sound during inspiration, and when they are very large they give rise to a dull sound upon percussion; but the diagnosis of this form of tuberculosis is often very difficult.

Tuberculous diseases of the *bones and joints* may cause lameness and enlargement of the affected parts. In cases of *udder tuberculosis* the diseased quarter is the seat of a hard, painless enlargement that may be nodular but is more often diffuse; while in cases of common udder inflammation the milk is rapidly altered, becomes watery, flocculent or purulent, and often fetid. It is very characteristic of tubercular mammitis that the milk from the affected quarter retains for a long time, often a month or more, its natural appearance; later on it becomes watery and clotted, but it is very rarely purulent, and never fetid. The lymphatic gland above the udder is always enlarged, often very much. The tuberculous nature of an udder disease is ascertained by microscopical examination of the secretion from the diseased quarter, in which the bacilli are easily found either in the small flakes or flocculi in case of the milk being unchanged, or in the sediment after centrifugation. The demonstration of tubercle bacilli in any suspected discharge is of course the best proof; and this method is not only used to

examine a suspected udder secretion, but also a discharge from the vagina, urine, or sputum in cases when this can be found in the nostrils, or when it can be obtained from the throat with the hand or with a sponge.

Tuberculous animals may remain in good flesh for a considerable time, even when they have rather large deposits in the body, especially in the form of pearly disease. The appetite may continue rather good for a time, and the cow continues to give milk, although this secretion gradually diminishes. As the disease progresses, *emaciation* and paleness of the mucous membranes and the skin will become more and more manifest; the coat will be staring and the skin harsh and dry. Diarrhœa may be observed, although it is not a common symptom. If the animal is not killed it dies from exhaustion after a period of illness which may last for months or years.

While the course of the disease is generally very slow, it may sometimes change and become rapid. This occurs when large numbers of tubercle bacilli are discharged into the blood or lymph currents. They are then carried to many organs, and cause in a short time the development of numerous very small nodules—'miliary tuberculosis' (galloping consumption). We then observe fever, rapid loss of flesh, depression, poor appetite, cough, rapid breathing, weakness, and sometimes enlarged lymphatic glands. This form always terminates in death in a short time. It is more common among swine than in cattle.

Frequency and Significance of the Disease.—Although tuberculosis attacks most species of warm-blooded animals, cattle are, in addition to man, the chief carriers of the disease, and there is no doubt that the other animals—at least the mammals—mostly are infected from cattle. In swine this is very evident, for in dairy countries these animals are generally infected by feeding with raw dairy products containing tubercle bacilli, sometimes also by eating carcasses or organs of tuberculous cows. In the United States, swine are frequently infected by following cattle and eating their fæces. Horses are also generally infected by cows' milk given to them when diseased, or in some countries (as in Denmark) in order to fatten them for sale. In some countries, for example Germany and Switzerland, cattle tuberculosis was a well-known disease many centuries ago, and in the last century the disease has been widely spread in most civilized countries. Most prevalent it seems to be in Germany, Denmark, South Sweden, Holland, Belgium, Austria, Switzerland, Great Britain, but it is also rather common in France, in the United States, and in many other countries. It can be proved that it has been introduced into many countries where it was formerly unknown, as, for instance, Denmark, Sweden, Norway, Finland, Japan, and Australia, by means of cattle imported from Switzerland, Germany, Great Britain, or other countries, just as is the case with other contagious diseases.

Statistics from slaughter-houses in Germany and many other countries seem to show a rapid increase in the frequency of the disease during the last few decades; and this is probably true, although the figures must be regarded with some reservation, because the veterinary inspection is undoubtedly carried out much more carefully now than formerly.

At all events, it is certain that tuberculosis has to-day a great prevalence in many countries. It must be remembered, however, that even in the most infected ones by no means all herds are affected. Usually a large number are completely healthy. This is because tubercle bacilli are not at all ubiquitous. They are never found except in places where animals (or human beings) discharging tubercle bacilli live or have lately lived. Tuberculosis is a purely *contagious* disease. Only such herds are perfectly healthy as are kept up by *breeding*, receiving hardly any increase from outside, except a calf now and then, while the prevalence of tuberculosis is generally the greater the more frequently the stock is increased by *buying cattle at fairs*.

If a tuberculous animal is introduced into a hitherto healthy herd, the risk of contamination varies very much, according to the development and the form of the disease. As long as the tubercular deposits are closed, the animal will not be able to contaminate; but when they open to a surface and bacilli are discharged, contamination will take place. Thus, as a rule, other animals will be infected after some time, and in the course of years tuberculosis will generally spread more and more. Therefore, where a *tuberculin test* is made in large herds in which the disease has existed for years, we usually find the great majority of the cows reacting.

In most cases it is proved by this test that *tuberculosis is more prevalent among old than among young cattle*. A close examination of 40,624 head of cattle, which were subjected to the tuberculin test for the first time, has shown to the author that of calves under six months 12·1 per cent reacted; of yearlings (from six to eighteen months), 27·5 per cent; of two-year-olds (one-and-a-half to two-and-a-half), 38·6 per cent; of full-grown animals (from two-and-a-half to five), 44·9 per cent; and of animals over five years old, 48 per cent—figures which correspond with the results of tuberculin tests in other countries, and with the results of the study of human tuberculosis.

The *social significance* of animal tuberculosis is *hygienic* as well as *economic*. As long as it was considered a fact that bovine and human tuberculosis were identical diseases, both caused by the same microbe, it was generally admitted that bovine tuberculosis was one of the sources of the 'great white plague' in man, although most scientists agreed that man himself played the more important part in the infection of mankind. Therefore, in most countries, hygienists urged the necessity of combating tuberculosis in cattle and other domestic animals because milk and milk products as well as meat might be dangerous to public health. Th. Smith first pointed out some differences between tubercle bacilli from man and from cattle in growth as well as in virulence, but it was especially R. Koch who made the identity of the two

diseases a burning question when he, at the Congress on Tuberculosis held in London in 1901, declared that human tuberculosis differed from bovine and could not be transmitted to cattle. He did not absolutely deny that man might be susceptible to bovine tuberculosis, but he estimated the extent of infection by 'milk and flesh of tubercular cattle, and the butter made of their milk, as hardly greater than that of hereditary transmission, and he therefore did not deem it advisable to take any measures against it'.

This startling expression occasioned very numerous investigations in different countries, especially in England (Royal Commission on Tuberculosis), in Germany, and in Denmark, the result of which may be said to be that Koch had gone too far. The English Commission, for instance, found that, out of 60 cases of tuberculosis in man, not less than 14 contained bacilli that were as virulent to cattle as bovine bacilli; and German investigators found this to be the case with 9 out of 67. If the character of the bacilli indicates their source, it must consequently be said that, out of 127 cases of tuberculosis in man, not less than 23 (18 per cent) must be considered infected from cattle. Therefore it is the common opinion to-day that bovine tuberculosis ought not to be lost sight of as a source of human tuberculosis. There is no doubt that milk is much more dangerous than meat, and there can hardly be any doubt that children, especially infants, are much more liable to be infected in this way than are adults. Milk is, of course, specially dangerous in cases of udder tuberculosis; but also when the milk does not contain tubercle bacilli when it comes from the udder, it may easily be contaminated with such bacilli by means of particles of the faeces from tubercular cows, or from vaginal discharge from a cow suffering from uterine tuberculosis. Cows with udder tuberculosis, therefore, ought to be killed as soon as possible; and cleanliness in the byre and in the milking should be strictly observed.

Koch had gone too far; but even if he had been right in considering bovine tuberculosis harmless to man, there would be reason enough for farmers to combat tuberculosis in animals with might and main, because it is to-day one of the worst scourges to cattle, and in many cases also causes severe losses in swine and poultry. It is true that statistics showing that, for instance, in some German slaughter-houses 30 to 50 per cent of adult cattle are affected with tuberculosis, and that in many large herds in different countries 80 per cent or more of the cows react when tested with tuberculin, give an exaggerated idea of the significance of the disease, in as far as the *great majority of such cattle are only slightly affected* and are able to supply sound meat, and milk perhaps for many years.

Tuberculosis indeed interferes severely with the economic results of stock-keeping and breeding. It is a very insidious disease, and years may pass before the farmer observes that there is something wrong in his herd. But by and by he finds that more and more of his cows do not pay for their fodder, that they are becoming emaciated and yield too little milk. Before that stage has been reached the butcher will sometimes tell him that a carcass has been deemed unfit for human food, and later on he will often have to sell the poor animals for a mere song. While in the beginning mostly the older cows show clinical symptoms, this may later on be the case with heifers or calves, and it is no uncommon thing that most of the herd is ruined. This causes a heavy loss in a herd of common cows, and much more when it happens in a valuable herd.

Treatment.—In human beings it is a problem of the highest importance to find the best cure for the diseased individual, and to-day we are happy enough to know that it is often possible by means of good hygiene and dietetics to assist nature in its effort to stop the evolution of the disease. The same may, of course, be said of tuberculosis in animals. Good food, plenty of light and air, are also here remedies that strengthen the resisting power of the organism; and at the same time good hygienic conditions in the byre—light, fresh air, and cleanliness—are of great importance as a means of preventing contamination.

Still more important than cure is prevention, and in animal tuberculosis it must be the chief problem to find out how to prevent the disease. *As tuberculosis cannot arise unless tubercle bacilli gain entrance into the body, the problem is to prevent this occurrence.* Now, where are the tubercle bacilli? They are all discharged from sick animals or human beings, but they remain living outside the body for a certain time. Consequently they are not to be found everywhere, but they exist in localities where animals or human beings, affected with open tuberculosis, live or have lately lived, and they may be contained in meat, milk, and milk products coming from tubercular animals or contaminated by discharge from such animals. As to infected localities, closed sheds or byres are much more dangerous than open fields, and the darker and more ill-ventilated and unclean the stables are, the greater is the risk of contamination.

Another capital point is that hereditary transmission is of rare occurrence. *The great majority of calves are born healthy*, even when the cow as well as the bull is affected with tuberculosis, and *they must remain healthy when they are not exposed to contagion.* These are the simple ideas on which prophylactic measures against tuberculosis must be founded, and that they are correct is proved by experience.

If a man has a tuberculous herd, he is able to convert it gradually into a healthy one if he removes the new-born calves from the infected stable and places them in an isolated, healthy room, and when he gives them milk which does not contain—at least in a living state—tubercle bacilli, *i.e.* pure milk from absolutely tubercle-free cows, or milk that is heated sufficiently to destroy the bacilli.

Isolation of calves is a measure that can be accomplished without difficulty on most farms; and it is indeed very strange that every breeder—and especially the breeder of valuable cattle—does not take this simple measure, but that so

many of them thoughtlessly place their healthy new-born calves in the infected cow stable, although experience has clearly shown that young individuals are very easily contaminated. Not more difficult will it be, as a rule, to keep the heifers isolated; such animals do not need expensive byres. It is more difficult, of course, to continue the isolation when the heifer has calved; but when the farmer understands how much more valuable are healthy cows than tubercular ones, he will surely spend the money that is necessary for the construction of a new byre for the healthy herd, or at least to divide his old byre by means of a light wooden partition.

Forming a new healthy herd will be an easy matter if it is possible to place it on another farm, such as owners of large estates frequently will be able to do. When the new herd must be placed on the same farm as the old infected herd, there will always be some risk of contamination, because tubercle bacilli discharged from the sick animals may be carried to the healthy ones by means of persons, dogs, cats, or other animals, and the shorter the distance is the greater the risk will be. But it must be kept in mind that it is the housing *in the same byre or shed* together with sick animals that is by far most dangerous.

And now we are fortunate enough to possess a method that enables us to recognize very early if an animal is infected with tuberculosis or not, viz. the *tuberculin test*. Tuberculin is an extract of tubercle bacilli cultivated in bouillon with glycerine. The bacilli are killed so that the fluid cannot infect; but it has, when injected under the skin of an animal, the marvellous property of producing a typical fever, which appears after some hours and lasts about twelve to sixteen hours—so-called reaction—if the animal is affected with tuberculosis even in the slightest degree, while a healthy animal is not at all influenced by the injection. Tuberculin was for the first time prepared by Koch in 1890. He hoped to have found a remedy to cure tuberculosis, and tuberculin seems indeed to have some curative influence, though not as much as hoped; but its diagnostic property is recognized by all, and the tuberculin test is used on a very large scale, especially in animal tuberculosis.

It is true that tuberculin is not absolutely infallible. Very old small tubercular deposits enclosed in a thick layer of fibrous tissue sometimes fail to call forth a reaction, but that is of no practical consequence, because such deposits will as a rule do no harm. A worse thing is that animals suffering from tuberculosis in a very high degree sometimes cease to react. This fact has sometimes done much harm, because such animals will usually have open tuberculosis, and their presence in a healthy herd may therefore occasion much contamination; but when the person in charge is aware of the danger, it will as a rule not be difficult to recognize the disease by clinical examination. It is still worth mentioning that repeated injection of tuberculin may in some animals provoke immunity to the test, which may be used by a cattle dealer with intent to defraud; but all these deficiencies cannot outweigh the great merits of tuberculin when used in the right way.

In his endeavour to form a new healthy herd by breeding from the old infected one, the farmer will have most valuable assistance from the tuberculin test. The new herd should be tested once, or better twice, a year in order to discover as soon as possible if an animal has been infected, and then to remove it from the healthy herd and slaughter it, or place it in the old herd. If the isolation of the healthy animals has been maintained carefully, the number of reacting animals will be very small, if any, and *every breeder*, when he follows this method strictly in the course of some years, *will be able to free his herd from tuberculosis*. This measure was for the first time proposed in 1892 by the author, and is known as the Bang method. It has been carried out with excellent result in many herds in Denmark as well as in several other countries, although it has not nearly as yet come into such common use as it deserves.

One of the chief reasons why this method has not been generally applied is that instead of taking the slow but sure way of *beginning with the calves*, it has been the desire to shorten the way and to begin the work by testing the whole herd with tuberculin, and forming a new healthy herd by separating the non-reacting animals from the reacting ones. This measure is quite recommendable when only few animals in the herd are infected, but where the great majority reacts, such as will usually be the case in large herds which have been exposed to tuberculosis for many years, it is usually unwise. The immense number of reactions generally frighten the proprietor, and he will often lose his reliance on the test and feel inclined to give up the whole work when drawbacks occur. When the number of animals that have to be isolated is great from the beginning, it is of course much more difficult to maintain the isolation strictly than it is when we begin with some calves, and drawbacks are much more likely to occur under such circumstances. When we begin with isolation of the older cows there will also be more risk of the serious mishap of placing a very tuberculous but not reacting cow in the healthy division. These difficulties are avoided when we begin the work by simply testing and isolating the calves, or perhaps calves and heifers, and letting the adult animals remain untested. The author has since 1899 recommended this plan for herds in which it was known in advance that tuberculosis was widely spread.

In Denmark it is the custom not to let calves suck the cow, and it has therefore not been difficult to feed them on uninfected milk—*i.e.* milk that is sufficiently heated, or milk from a few perfectly healthy (non-reacting and clinically examined) cows. The first few days, however, the calves must have the colostral milk of their mothers. In countries where the 'artificial' feeding is unknown, a way out of the difficulty would be to make some perfectly healthy cows act as wet nurses and suckle the calves. Indeed, as has been proved by the Hungarian Ujhelyi, good results may be achieved even if the mothers are allowed to nourish their own

calves, provided the calves are kept in separate stables except when they are let in to their mothers for feeding two or three times a day. This breaking away from the isolation rule involves, of course, some danger of infection; there is, however, a great difference between such a brief exposure to infection and constant cohabitation in the same byre day and night.

In order to obtain a good result from the isolation method—at least when the healthy herd is on the same farm as the infected one—it is necessary to remove as soon as possible from the latter very badly affected cows that daily discharge thousands of millions of tubercle bacilli. It is evident that the greater the number of such cows in the infected herd the greater risk there will be of carrying the bacilli into the healthy herd. Luckily it will always be to the interest of the owner to slaughter such animals as soon as possible.

The comprehension of the fact that animals with open tuberculosis are the real spreaders of contamination has led to the idea that it might be possible to combat tuberculosis in cattle effectually enough by means of a careful clinical examination of the herd, followed by a rapid removal of the dangerous animals. This is the method of Ostertag, combined with a temporary isolation of the young animals until their first calving. This method is frequently used in Germany. It is beyond doubt that it is possible in this manner to ameliorate the sanitary condition of the herd, but we will certainly not be able by these measures to get completely rid of tuberculosis, as we can do when we maintain the isolation of the young healthy animals, being assisted by the tuberculin test. The reason is that clinical examination, even combined with laboratory tests, does not at all enable us to detect all dangerous animals. We may find those that are momentarily the most dangerous, but in the time which elapses between two examinations the disease will progress in many animals to such a degree that they discharge numbers of bacilli.

Some years ago the hope arose that it would be possible by means of vaccination (Behring, Koch, Schutz, Pearson, Valee, Calmette, Klimmer, Heymans, and others) to produce immunity against tuberculosis, and that the great problem of eradicating this disease might be solved in that way. It is beyond doubt that a certain degree of immunity may be created, but it has not sufficient duration, and by the most effective method, in which living human bacilli are used, the meat and milk may be dangerous a rather long time. Vaccination experiments are still being carried out in several places, but it must as yet be considered doubtful if a practical solution of the problem will be found in this way. Thus the isolation method is still the only one which enables us to eradicate completely tuberculosis in an infected herd.

Tuberculosis cannot be stamped out unless the farmer himself does the main work, but it is a natural desire that the State should assist him. The State should deliver tuberculin free of charge, and pay for the assistance of the veterinarians in all cases where the farmer uses the tuberculin test in the right way, *i.e.* as a means to secure the forming of a new healthy herd. It would also be desirable that the State should assist farmers to rapidly remove the animals suffering from open tuberculosis. It is true—as before said—that this removal is to the interest of the owner rightly understood; but it cannot be denied that he does not always realize this clearly, and therefore such animals are very often not removed in due time.

As the rapid slaughter of dangerous animals —*i.e.* especially cows with tuberculosis in the udder or in the uterus, and with open lung-tuberculosis — is a very useful measure, generally speaking, it has in many countries been regarded as one of the first objects of the State to carry this measure into action. It must be remembered, however, that it will cost lots of money, and that the slaughter of and partial compensation for such dangerous animals, if nothing else is done, is certainly able to diminish the extent of the disease but not to stamp it out. If the State restricts the compensation to dangerous animals killed on farms when the owner himself makes serious attempts to eradicate the disease, the profit will be certain.

One of the dangerous forms above cited, viz. the udder tuberculosis, has a special interest from a sanitary point of view, because the milk from a tuberculous udder is very dangerous not only to young animals but undoubtedly also for children. It seems then to be a natural desire to have such animals killed as soon as possible, and to pay a compensation for that purpose. This has been done in Denmark since 1898.

Interference of legislation is undoubtedly required in order to prohibit dissemination of tuberculosis by means of skimmed milk, buttermilk, and whey when these products are returned to the supplier from a co-operative dairy. Among the suppliers of a dairy there will generally be one or more farmers who have a highly tuberculous herd, one or more cows of which yield in the course of the year great quantities of infected milk, and so by employing this milk, after it has been skimmed, to feed calves and pigs in other herds, the infection is spread to hitherto healthy herds. In Denmark attention was directed to this danger many years ago, and it is there generally considered the most important of the measures taken against tuberculosis in animals that the Tuberculosis Act of 1898 ordered the heating of skimmed milk and buttermilk to 80° C. (at first to 85° C.) before it is returned from the dairies. The observance of this law is controlled by means of Storch's colour test, which consists of pouring a few drops of paraphenylene-diamine and of peroxide of hydrogen into the milk. The milk turns blue if it has not been heated to 80° C. It is of course a fault that the law does not require heating of the whey, but on that point the law will probably soon be amended. It is also worth mentioning that the Danish law requires heating to the same degree of the cream destined for the making of butter for exportation. [B. B.]

Tuff.—A mixture of volcanic ash and ejected

blocks is styled a tuff. Tuffs thus vary in composition according to the nature of the lava masses of which they are the exploded representatives. Modern tuffs form light porous soils, as in the neighbourhood of Vesuvius, in Auvergne, or in Japan, with chemical supplies easily accessible, owing to the large amount of surface that they provide, combined with their permeable character. Ancient tuffs, however, have their interstices filled up by growths of secondary minerals, and they become compact and even flinty, like the corresponding lava flows, when they possess any high degree (say 65 per cent) of silica [G. A. J. C.]

Tufted Hair Grass, a coarse, fibrous-rooted perennial grass which ranks as a weed in pastures. See AIRA

Tulip, a large genus of very popular and beautiful hardy bulbous plants (nat. ord Liliaceæ), natives of Europe, North Africa, and a great part of Asia. The flowers are erect, rarely nodding, and produced one (rarely two or three) on a stem. They are not pleasantly scented. The bulbs are fleshy and covered with a brown skin. The Garden Tulip (*T. Gesneriana*) was introduced from the Levant in 1559, and rapidly became popular throughout Europe, many varieties being raised. The tulip mania which raged in the 17th century, notably in Holland, is historical, and has never been surpassed in horticulture, if indeed in any kind of commerce. Bulbs were bought and sold without even being seen, for as much as 4600 florins apiece. But it was not merely a passing phase, for tulips are still a source of considerable profit to the Dutch, though it is now the cheaper sorts that are chiefly raised, and in prodigious numbers. New varieties are obtained from seeds sown in February in a cold frame. They flower in four or five years. The usual method of propagation is by offsets, which are abundantly produced. They are grown in specially prepared beds of sandy loam, leaf mould, and manure. Tulip bulbs are planted 3 in. to 4 in. deep, usually about 6 in. apart, in October or November, and preferably in rich but rather light soil. After flowering, they should if possible be left in the beds until the foliage turns brown, or else lifted and replanted in the reserve garden. When thoroughly ripened the bulbs should be stored in an airy place. Great care must, of course, be exercised respecting the arrangement of colours and selection of sorts which flower simultaneously. The singles are more popular than the double-flowered kinds. Tulips are also very popular for forcing in pots and boxes from December onwards. There are numerous fine garden varieties, which are divided into the following sections: Single- and Double-flowered Early or Dutch, Late Double-flowered, Parrot or Dragon Tulips, Darwins or Selfs, and Florists' or English Tulips, the last named being but little in favour now. Many of the species are also well worthy of border or greenhouse cultivation. [W. W.]

Tulip. — Bulb Rot. — Every year complaints are heard of purchased bulbs not flowering, or that the bulbs die away after flowering one or two seasons. This is also a serious pest in Holland, and is imported with the bulbs. It is most frequently caused by fungi, which form crusts of black sclerotia or resting-bodies on the bulb-scales; from these fungus-filaments grow out and kill the roots of the bulbs, thus interfering with flowering and with growth of new bulbils (see also HYACINTH — PARASITIC FUNGI).

Treatment. — The following is recommended in a Dutch paper. Use only clean bulbs free from scabby crust on the inside of the outer bulb-scales, remove and burn all diseased bulbs with all soil adhering; infected plots may be cleaned by cultivating non-bulbous plants for several years, or by skimming off the top soil and replacing it with clean soil and the ash from burnt garden rubbish. [W. G. S.]

Tulip Root, a disease which affects oats and other cereals, and caused by a minute nematode worm. See TYLENCHUS

Tull, Jethro. The father of the drilling and horse-hoeing system of husbandry was born in 1674 and died in 1741. A gentleman of moderate fortune, Tull was educated at Oxford, and was trained for a legal career and admitted to the bar, but abandoned law, and devoted himself to farming. He spent two or three years in European travel, in the course of which he gave much attention to the agriculture of the countries visited. As a farmer he had a useful though eccentric career, having first occupied a farm of his own in Oxfordshire, afterwards another near Hungerford in Berkshire, where he died. Impressed with the great value of the thorough cultivation and aeration of the soil, Tull conceived the mistaken idea that nothing else was needed to sustain its fertility, and for years, if not up to the end of his life, he preached the doctrine of cultivation without manure. He invented a drill and a horse-hoe, sowing his crops in rows instead of after the broadcast fashion at that time universal in England, and widely apart enough to allow of thorough cultivation between the rows. As his soil was naturally fertile, his system for a time appeared to be a great success, and not a few visitors were impressed with the value of the 'new husbandry' as it was called. It was adopted by a few venturesome men, but not by the practical farmers of Tull's time, who, indeed, ridiculed it, and declared that he was a lunatic. All who tried the system, like Tull himself, found in the course of time that it was based on an incomplete theory of plant nutrition, and its failure threw undeserved discredit upon what was really of very high value in it. If Tull had added manuring to his drilling and horse-hoeing system, he would have gained a degree of success which would have caused his example to be followed extensively many years before even what was good in it was commonly adopted. But long after the signs of soil exhaustion showed clearly in his crops, he stuck to his beloved theory. In 1733 Tull published the first edition of The New Horse-hoeing Husbandry, to which additions were made subsequently. A second edition appeared in 1743, and the work was translated into French. He grew turnips as a field crop, it is believed, before any other man in Great Britain; but even in this

highly valuable novelty his example was not followed to any considerable extent until Lord Townshend's highly successful cultivation of the crop in Norfolk (see TOWNSHEND) had attracted widespread attention to it. [W. E. B.]

Tumours and Growths.—Any enlargement, whether temporary or permanent, is spoken of as a tumour, though the word generally implies something permanent, if not malignant. Tumours are conveniently divided into benign and malignant. The simple fatty fibrous tumours which form beneath the skin where harness gives rise to friction, may be taken as examples of the benign. The cancers are malignant. The simple or benign tumours are examples of increased nutritive activity of the elements they originate from, they are independent of the rest of the body, and either go on increasing of their own inherent activity, or arriving at a certain development remain stationary. A tumour is not a new tissue, but whatever its nature it is the product of a pre-existing tissue. Their causes are obscure, but there would seem to be a strong hereditary tendency in some families, and a predisposition in certain colours, as with grey horses to melanotic or pigmentary tumours, and in the Yorkshire and Airedale terriers to pigmentary tumours scattered over the body or under the surface of the skin, or as little bags of pigment, or in the more familiar form of warts. Tumours of the fibrous type get the name fibroma, of the adipose, lipoma, cartilaginous, enchondroma; bone, osteoma, mucous tissue, myxoma; the lymphatic tissue, lymphotoma. A second class of higher tissues affect muscles, nerves, blood-vessels, the papillæ of the skin, and secreting glands, and are known to surgeons as myoma, neuroma, angioma, papilloma, and adenoma. A third class are of the type of embryonic connective tissue. The malignant tumours commonly called cancer are grouped as sarcomata and carcinomata, and have distinctions for the surgeon which we need not enter into here. Our chief concern with animals is to ascertain if tumours are merely disfiguring or inconvenient, and capable of removal; or specific, and indicating such diseases as tuberculosis, or malignant, and inoperable and incurable, as is most generally the case in the retrograde cell formations recognized broadly as cancer. Cystic and pedunculated tumours offer the best prospects to the operator, and the cancerous the worst, as they creep into and convert the surrounding tissues to their own likeness. [H. L.]

Tup. See art. RAM.

Turbines.—A turbine is a motor for utilizing the energy of water, steam, or gas by causing it to flow through buckets, or over curved vanes contained within, or attached to a rotating wheel on which the fluid exerts a reactionary pressure constituting the driving force. Formerly, the term 'turbine' was applied only to horizontal water-wheels, but the modern term has a very much wider meaning. A turbine consists, essentially, of a rotating wheel and a fixed casing containing guide passages. In addition, there are, usually, arrangements for controlling the quantity of water used and for regulating the speed.

All water turbines may be divided, according to the action of the water on the wheel vanes,

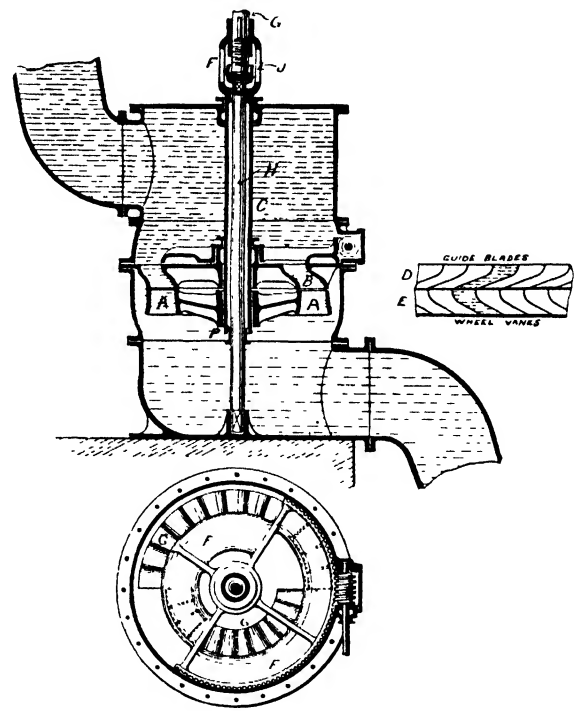


Fig 1.—Jonval Turbine[1]

into Impulse Turbines and Pressure or Reaction Turbines. In an impulse turbine the water enters the wheel without pressure (excepting that of the atmosphere), and its energy, therefore, is entirely due to its velocity; that is, it is entirely kinetic. In passing through the turbine the water impinges upon the buckets, or vanes of the wheel, and thus imparts its energy to the wheel by means of the impulse due to the gradual change of momentum which the water undergoes. Further, in passing through the turbine the water can deviate freely, as the pressure throughout is atmospheric—a condition which is ensured by never allowing the wheel passages to be completely filled, or by 'ventilating' the buckets—consequently impulse turbines are 'Turbines of Free Deviation' or 'Free Jet Turbines'.

[1] Figs 1 and 5 are reproduced from Lineham's 'Mechanical Engineering' By permission

In pressure or reaction turbines, on the other hand, part of the available fall is reserved to produce pressure; the usual practice being to use one-half of the fall to obtain pressure at the inlet surface of the wheel and the other half to produce velocity of flow. In consequence of the pressure in the buckets of reaction turbines being thus greater than that of the atmosphere, it is a necessary condition, in order that they may work properly, that the wheel passages should be continuously filled, a condition which renders such turbines suitable only for medium, or large flows and low falls. In purely impulse turbines, however, the buckets are never filled, and they will work satisfactorily and without any loss of efficiency with admission over a portion only of the inlet surface of the wheel. Consequently impulse turbines are pre-eminently suitable for high falls and small flows.

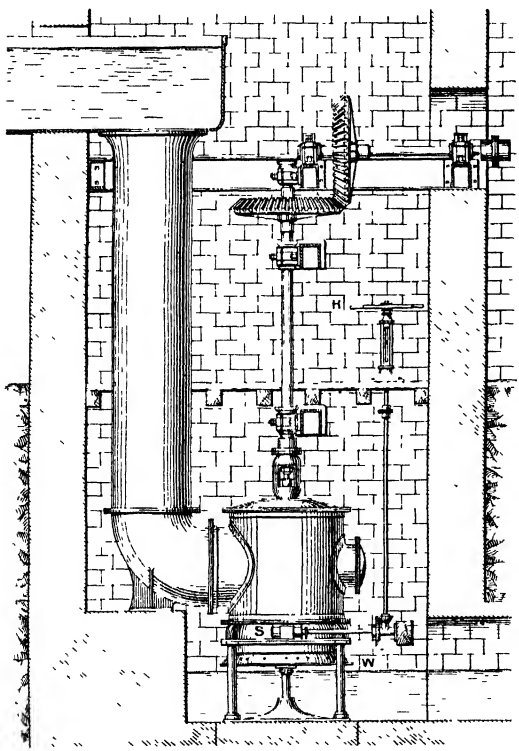


Fig. 2.—Girard Turbine (W. Gunther & Sons, Oldham).

Turbines may also be divided, according to their construction, into four classes, viz. axial or parallel, radial-outward, radial-inward, and mixed-flow. In axial-flow turbines the water flows through the wheel in a direction generally parallel with the axis of rotation. In radial-flow turbines the water flows in a direction generally at right angles to the shaft or radially, and in mixed-flow turbines the flow is partly radial and partly axial.

An axial- or parallel-flow turbine of the pressure kind, known as the Jonval turbine, is shown in fig. 1. The wheel casing, A, consists of two concentric cylinders to which the curved vanes, contained in the annular space between them, are secured. Immediately above the wheel casing there is a similar, but fixed, casing, B, containing the curved guide vanes. The small figure at the right-hand side shows, at D, the form of the guide vanes and, at E, the form of the wheel vanes. As the water from the guide passages enters the wheel it impinges upon the curved vanes of the latter, causing the wheel, the hollow tube C to which it is attached, and the shaft G to rotate. The regulation of the speed is usually effected by closing the guide passages in succession by means of a slide or slides. The Jonval turbine works best when 'drowned' or below the level of the tail water, it is, however, sometimes placed considerably above that level, in a suction tube kept full of water. On low falls, or on medium falls where the tail water is liable to frequent fluctuations of level, the Jonval turbine is preferable to any other type.

The general arrangement of an axial-flow turbine of the impulse kind, called a Girard turbine, is shown in fig. 2. In this turbine the wheel casing, W, is provided with a number of small ventilating holes, and instead of consisting of two concentric cylinders the walls of the casing are splayed out, thus making the wheel passages wider at the outlet than at the inlet surface. In Girard turbines each jet works independently, consequently any number of guide passages can be closed without lowering the efficiency of the motor appreciably. In the example illustrated in fig. 2, the closing or opening of more guide passages is effected by turning the hand wheel H, which, being connected by gearing to the slide S, causes the latter to move so as to close or open more guide ports as required.

A radial-outward flow turbine of the pressure type, called a Fourneyron turbine, after its inventor, is shown in fig. 3, the upper figure representing a vertical section and the lower figure a horizontal section through the wheel and guide chamber. In this example, which is arranged for a low fall, the wheel A is divided by horizontal partitions into three parts, which are practically separate turbines connected together, one above the other. The water from the reservoir C enters the guide wheel D, which is furnished with curved guide vanes, as shown in the lower figure (fig. 3), and thence flows through the wheel A. The vanes of the wheel are curved in such a way as to deflect the water, causing it to be discharged in a radial direction after giving up some 70 per cent or 80 per cent

of its energy to the wheel. The regulation is effected by means of the hollow, cylindrical sluice-gate F (in which there are slots to admit the guide vanes), which shuts off the water in succession from the upper, the middle, and the lower compartments of the wheel. The Fourneyron turbine was practically the first of the turbines in the modern sense of the term; and

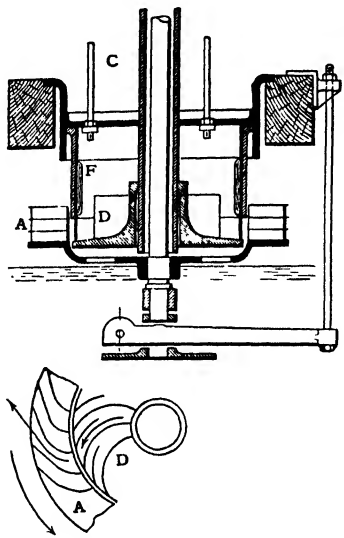


Fig 3 Fourneyron Turbine

though there are many modifications of this type, they are essentially of the same construction, and all suffer the defect of being difficult to control under varying loads For as the speed increases under a diminishing load, the centrifugal force of the water in the wheel increases, which causes a greater flow through the wheel and a further increase of speed. Consequently, radial-outward flow turbines of the pressure type are not much used now, having been practically superseded by the Jonval turbine Radial-outward flow, *impulse* turbines, such as the Girard shown in fig. 4, are, however, used very considerably. This is a partial admission turbine with a horizontal shaft, but similar turbines with vertical shafts are equally common. In these turbines the water is admitted over only a limited portion of the circumference of the wheel, and the wheel is made of such a diameter as will give a suitable speed of rotation even when the fall is 200 ft or more The adjustment consists of a segment slide worked by suitable gearing and arranged to open the guide passages in succession.

Radial-inward flow and mixed-flow turbines are always of the pressure or reaction kind. A turbine of the former class is shown in fig. 5, which represents Professor James Thomson's Vortex turbine. The turbine wheel, B, shown enlarged in the side figures, is enclosed, eccentrically, in a vortex chamber, circular in section The water from the penstock enters this chamber at the point most remote from the wheel, and as it approaches the latter it assumes, naturally, a vortex motion, and thus requires very little guiding, if any, before entering the wheel. The four guide blades, D, are pivoted to the casing near their inner ends, and their outer ends are connected to a circular plate (worked by a hand wheel through suitable gearing) so that by a slight motion of the plate they are all moved simultaneously and the area of flow increased or diminished. In this way the regulation is effected without altering, appreciably, the angle of the guides, and as a small movement of the guides greatly affects the flow through the wheel, the speed and power are quickly and readily controlled. Further, as the centrifugal force of the water in the wheel increases rapidly as the speed increases, and as this tends to choke the flow of water through the wheel, the turbine is, to a certain extent, self-regulating. For these reasons the Vortex turbine is particularly well adapted to dynamo driving; and for medium or large powers and under heads ranging from about 50 ft. to 150 ft., this class of turbine is generally more suitable than any other. For lower falls than 50 ft., however, a Jonval turbine would be preferable, and a Girard, radial flow, would be better when the fall exceeds about 150 ft.

A type of turbine which was first introduced in America, and is now extensively used there, is the so-called mixed-flow turbine. In this turbine the water enters the wheel at its outer circumference in a radial direction and leaves it in an axial direction. The object of this mixed-flow principle is to reduce the diameter of the wheel in order to increase the speed of rotation for a given fall.

When dealing with very large powers under only moderate heads, it sometimes happens that if a Girard or Jonval turbine were used, the

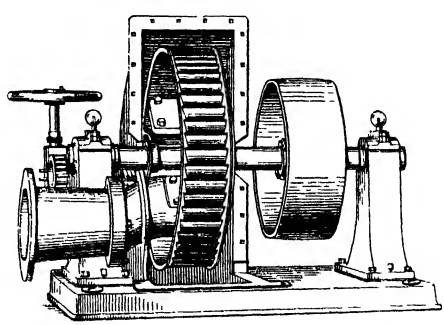


Fig 4 —Girard Turbine (W Gunther & Sons, Oldham)

diameter of wheel required would be inconveniently large, and would consequently run at too low a speed for the particular class of machinery to be driven. Under such circumstances a mixed-flow turbine could be used with advantage, as a smaller wheel could be used having a higher speed of rotation. Such turbines are suitable for the purpose of driving large electric-power plants, and particularly so

when the load is a steady one Under varying loads, however, they are not so satisfactory as either Jonval or Girard turbines, as their efficiency diminishes much more rapidly as the power falls below the normal.

From the above considerations it will appear evident that no particular type of turbine, whatever its advantages may otherwise be, is suitable everywhere, but that the type best suited to any particular case will depend upon the circumstances of that case. In general, however, for large flows and low heads, or with moderate flows under variable heads, pressure turbines are suitable For small flows and high falls a partial-admission impulse turbine is suitable, and an impulse turbine is also suitable for moderate flows when the fall is a fairly steady one. Further, radial-flow turbines, as compared with axial-flow turbines, have these advantages first, that the pressure due to the reaction of the water against the wheel vanes is not transmitted to the footstep bearing; second, that the losses due to angular differences, peculiar to axial- and mixed-flow turbines, are avoided, and third, that a greater speed of rotation may be obtained for the same fall. [H. B.]

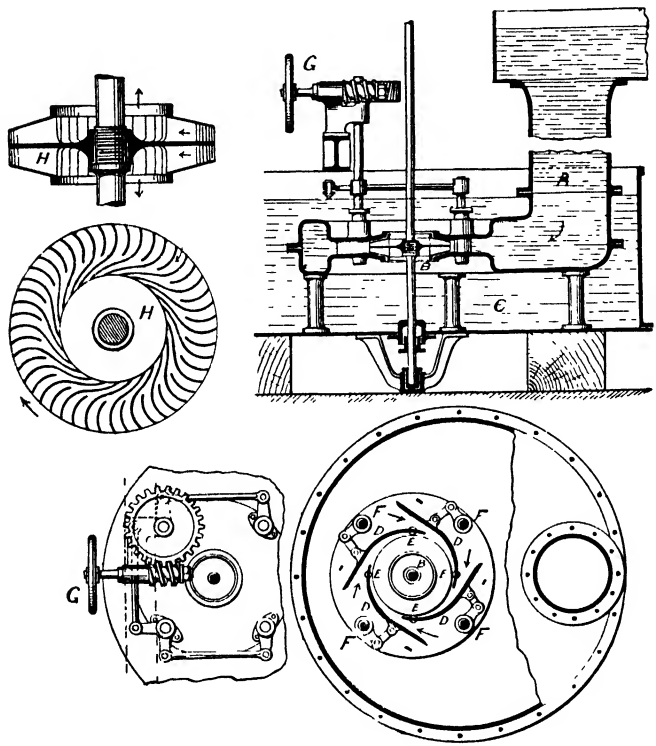


Fig 5 Prof J Thomson's Turbine

Turkey, Agriculture of. — See art. European Agriculture.

Turkey — Breeding and Rearing. — In breeding turkeys it is essential to remember that they require for their successful management abundance of room and fairly good land. Small holders and occupiers are not recommended to undertake this branch of the poultry industry, as there would be considerable danger of disease and loss arising from tainted soil. Moreover, these birds cannot make the same growth where they are under restricted conditions as when they have abundance of ground to wander over, and plenty of natural food. Neglect of this consideration has had disastrous results An opinion very generally held, and borne out by experience, is that the turkey is a delicate bird, more especially during the early stages of chickenhood One explanation of this constitutional weakness is the attempt to raise these birds on too small an area, and another is the use of immature birds for breeding stock The turkey does not attain its full maturity until its third year, and as a consequence the mating of yearlings which is so common tends to aggravate any delicacy of constitution there may be In fact, if continued generation after generation, such a practice would reduce the natural vigour Neither sex should be employed as breeders until their second season, and hens may be used for several years, but old cocks are undesirable as they are often too heavy for the hens One hen should be kept for every eight to ten chicks desired, and a male bird is sufficient for a score of hens or more

As far as possible, where large trees are available it is better to let the turkeys roost in these, as they do better than under cover But that is not always possible, either owing to the absence of suitable trees or to the danger from foxes, &c Where they must be housed, a large, lofty, well-ventilated, open-fronted shed may be used, having the front simply covered with laths of wood for protection. A better arrangement is secured by erecting a special building, with thatched roof and walls of furze bushes. This gives free ventilation without draught, and conforms nearly to natural conditions. Such a place should be 8 to 10 ft. high, and allow 15 sq. ft. of floor space for each one of the inmates. Perches are best made of 3-in fir poles, resting

upon stakes 3 ft. above the ground, the poles being 30 in. apart.

Turkey hens prefer to select their own nests. Empty boxes and barrels, or earth dug-outs, may be placed where they are hidden from observation, and the hens will generally choose these for laying. If eggs are removed and a dummy left in, more eggs are often produced When the hen keeps to the nest, eleven to fifteen eggs should be put under her. Apart from simply supplying her with food and water daily, she should be left alone during the sitting period The period of hatching is twenty-eight days; ordinary hens may be used for hatching turkey eggs, and are often preferred as they are more amenable to handling. Some breeders remove the eggs to an incubator two days before hatching, as turkey hens are often clumsy and crush the chicks, returning them after the youngsters are ready for transference to the coops, which latter should always be roomy and for the first week have a boarded enclosure in front, during which time it is preferable that the hen shall not have liberty Afterwards she may be trusted to her own instinct

Where the land is undulating or there is the protection of woods or belts of trees, shelter against wind is obtainable without any trouble That is important during the early stages of growth But the shelter should not deprive the birds of as much sunshine as can possibly be obtained Natural warmth, heat in fact, is an important factor in their development They are creatures of sunny lands One very excellent arrangement for providing shelter, securing fresh ground, and yet all the sunshine available, is adopted by some large turkey breeders This is to sow a field with rye grass or oats, and when well grown but still green, to cut a broad swath through it north and south, and in this to place the coops The turkeys are then protected against the wind, which blows over their heads, have the benefit of the sun's rays, and can find plenty of natural food The hen will strip the heads, on which the chicks will feed with avidity

Harm frequently results from giving too rich food The turkey makes greater growth in a given time than any other species of poultry except geese, and must have the elements for development. It is naturally a meat eater, consuming worms, grubs, insects, &c Where kept in considerable numbers these forms of food are soon exhausted, and fresh, sweet meat, such as cooked butcher's scraps (not fat), must be given In addition, the more nutritious grains and meals, such as oatmeal, biscuit meal, &c., must be supplied, tempting the appetite by boiled rice, and later giving wheat or buckwheat When the young birds have reached ten to twelve weeks, the ordinary foods may be chiefly depended upon, as far as possible seeing that they have as much natural food as possible. This is continued throughout the summer, when, if dry and hot, the use of woods is to be recommended, as there much more is obtained by foraging. A month's fattening (see POULTRY FEEDING), using as much milk as possible, brings them into condition for the Christmas dinner table. [E. B]

Turkey, Breeds of.—The wild Mexican turkey has a dark-brown plumage with a mixture of black, which coloration was seen in the domestic birds descended from it, and to it we owe such breeds as are now most common On the Continent of Europe the greater portion of turkeys are black, white, or grey. In the woodlands of North America the turkeys met with are much richer in colour than the Mexican, and it is from this species that the Bronze American and other races have descended. In this, instead of brown there is a brilliant bronze, which reflects the light, giving them a much richer hue. Nearly a hundred years ago the first importations of the American Bronze took place, but only within the last thirty years has the number increased materially. Now there are more of these in Britain than all other breeds combined Several of the best-known breeds are dealt with separately (see AMERICAN BRONZE TURKEY, BLACK TURKEY, CAMBRIDGE TURKEY, WHITE TURKEY), and only other two require mention.

Fawn Turkey is sometimes known as Buff or Chocolate, and are probably due to sports from the Bronze. The colour varies considerably, in some cases being a light-fawn, in others a light-buff, sometimes with lacings of white, and in yet others a red almost chocolate These are medium in size, and are kept primarily for exhibition

Ronquières — In Belgium is a breed which goes under this name, and is spoken of very highly for its table qualities, as it is a quick grower and carries beautifully white flesh. It is largely grey and black in plumage. [E B]

Turnip.—The term 'turnip' is applied to several more or less distinct biennial forms of Brassica with fleshy 'roots' which are grown extensively as food for cattle and sheep, many garden varieties suitable for use as table vegetables are also well known. See art. BRASSICA.

Although popularly called 'roots' or 'root crops', the thickened part of the plant called a turnip is not a *root*, but consists of the stem of the plant below the cotyledons, *i. e.* the hypocotyl, along with the upper portion of the true root

The annual and biennial forms or varieties which do not produce swollen 'roots' are known as rapes, and are grown for their oil-yielding seeds, and to some extent as green fodder.

The specific differences between the many kinds of turnips and the botanical relationships of the different varieties to one another are not clear. The following, however, may be recognized:—

1. The COMMON TURNIP (*Brassica Rapa*, L.) in the first year produces a swollen 'root' surmounted by a tuft or rosette of pale-green, lyrate leaves covered with rough hairs In the second season a flowering stem is sent up, the leaves upon it being lanceolate with ear-like bases, smooth and glaucous or ashy-green in tint.

The shape of the turnip is very varied, some being elongated like a carrot, others spherical and more or less flattened at the top. The part above-ground may be green, white, purple, crimson, or mottled green and purple. The flowers

of the turnip are of the ordinary cruciferous type (see Brassica or Cruciferæ), and the fruits are smooth, long siliques containing round, reddish-purple or claret-coloured seeds.

Two well-marked groups of common turnips are grown, viz: (1) the soft *white-fleshed* kinds, with canary-yellow flowers, and roots which, when cut across, appear white; and (2) the *yellow-fleshed* kinds, with somewhat darker yellow or buff-coloured flowers, and denser flesh, whose cells are filled with a yellowish or orange-coloured sap.

The latter varieties are sometimes styled *hybrid turnips*, it being formerly assumed that they were the product of crossing the white-fleshed turnip with the yellow-fleshed swede turnip mentioned below. This view is, however, erroneous.

2. The Swede Turnip.- This plant differs from the common turnip (*B. Rapa*) in possessing glaucous leaves in the first season of growth. These are, moreover, almost smooth, a few bristly hairs only being found on the younger leaves of the plant. The upper part of the 'root' is drawn out into a 'neck' or thickish stem. The specific gravity of the flesh of the swede turnip is also higher and of better feeding value than that of its relative, and the plant is less liable to be damaged by frost. The seeds are larger, round, and a dark purple tint, almost black.

Like the common turnips, the swedes may be divided into two classes, (1) the white-fleshed, and (2) the yellow-fleshed varieties.

The white-fleshed kinds, included under the specific name *Brassica napobrassica*, DC., have hardy, dense, irregular-shaped 'roots.' Their flowers are larger than those of the white turnip, but of the same tint, namely canary-yellow. These forms are not much grown.

The yellow-fleshed varieties are most commonly cultivated, and are spoken of in some districts as Rutabagas, and included under the specific name *Brassica Rutabaga*, DC.

The upper part of the 'root' is usually reddish-purple, or purple mottled with green, and the flowers are a pale-buff colour.

The author found that hybrids between the common turnip and swede turnip were sterile and unlike yellow-fleshed common turnips.

[J. F.]

Turnip, Field.– The turnip crop, including under that designation the swede as well as the white and yellow varieties, is the most extensively grown of all British root crops. It occupies a position of unrivalled predominance in the north and west of England, in Wales and in Scotland, and next to the potato is also the chief root crop of Ireland. In the middle and south of England, where the climate is too dry and warm to be entirely favourable to the turnip, it is cultivated with less success, and occupies a relatively less important position in the farming economy. The total area of the crop in England and Wales in 1909 was 1,115,042 ac., and in Scotland 440,506 ac., as compared with 432,523 and 142,938 ac. respectively devoted to the cultivation of the potato. The total annual value of the crop in Britain may be put at about £12,000,000. It is essentially a plant of a temperate climate, and it flourishes only in a cool and moist atmosphere. Hence its cultivation is only extensive in the northern countries of Europe, in Canada, and in some of the Northern States of the Union. In the south of England and in the warmer and drier regions of Europe it is very liable to succumb to attacks of mildew, and its yield is comparatively small. The climate of Scotland and of the north-west of England is very suitable, and that of Ireland is even more favourable. A dull showery summer and a mild open autumn are specially adapted to the turnip.

It is believed to be a native of Europe, and it was known both to the Greeks and to the Romans. It appears to have been grown in England as a garden crop from an early period, and turnips (*nepas*, 'neeps') are spoken of as well known before the Conquest. It was first cultivated as a field crop in the south-eastern counties, towards the end of the 17th century, by Sir Richard Weston, who learned the practice in Holland, where he had resided for a time as ambassador of Charles I. It was, however, Lord Charles Townshend, of Raynham, in Norfolk, who, about thirty years later, first brought into prominence the practice of growing the turnip as a field crop (see Townshend). But in spite of his influence, then field cultivation made little progress till the introduction of the system of drill husbandry by Jethro Tull in 1731. By the same time the second Earl of Stair, a noted agriculturist, is said to have grown turnips in Scotland in the fields. It was in the border counties that the system now generally prevalent of growing turnips on ridges, instead of broadcast as had been the previous practice, became first successfully established. Craig of Arbigland, in Dumfriesshire, drilled turnips in his fields in 1745, and in 1764 Dawson grew 100 ac. drilled in ridges on his farm of Harperton, near Kelso. The first peck of turnips was sown in the county of Ayr in 1772, a year memorable in the annals of the west on account of the failure of the Ayr Bank. The system rapidly extended into all parts of Britain coincidently with the practice of growing crops in a regular rotation, in which the cultivation of roots formed an essential feature. An event of great importance in the history of turnip cultivation was the introduction into Scotland in 1777 of Swede seed, so called because it was sent over by a Mr Airth from Gothenburg in Sweden to his father, who was then farming in Forfarshire. From this parcel of seed has been derived all the numerous varieties of swedes which now cover by far the greater part of the turnip area. Prior to this date only white and yellow turnips had been grown, and the introduction of varieties of superior hardiness, nutritive value, and keeping powers extended the utility of the crop in a very high degree, and rendered it capable of supplying the necessary green food for cattle throughout the whole of the winter period, when pastures are incapable of carrying a full farm stock. The great and even revolutionary improvement produced in British farming by the introduction of the turnip husbandry, its effects in abolishing the general practice of bare fallowing, the increase it gave in production of crop and in the stock-carrying capacity of the country, has been generally recognized; but the degree in

which that remarkable advance was due to the almost accidental transmission of a small parcel of seed from Sweden has perhaps hardly been fully appreciated

From that date onwards the turnip has occupied a leading position among British crops. Its adaptations to soils were quickly discovered. It was found that it could be most easily grown on all the lighter soils from sands up to medium loams, and that even on clay loams its cultivation could be quite successfully followed. On the stiffer clays the turnip was also found to grow fairly well, provided the plants could get a good start, but the difficulties of reducing such soils to a sufficiently fine surface to allow the young turnip plants to brand properly have militated against the general growth of the crop on them, while the roots do not spread so well, and the plants are liable to be injured by the souring of the soil in wet seasons Such soils are also liable to be damaged by the carting of the roots off the fields in winter, and sheep cannot be fed off on them Turnips do well on peaty soils and on dry free soils, but the heaviest crops of swedes are grown on rich medium loams, while yellow turnips do well on lighter soils, and whites even on the very poorest. These several groups differ from each other in agricultural value as well as in botanical characters The white brand more easily and grow more rapidly than the other sorts They are smooth-skinned and white-fleshed, and are soft in texture with a low percentage of solids They grow and ripen quickly, and are first ready for use. They are very suitable for successional sowing, and if sown late in the summer they stand the severity of winter very successfully They keep badly when mature, and must be consumed at once after raising They produce a large proportion of foliage, amounting, according to some of the Rothamsted results, to perhaps 16 per cent to 20 per cent of the total weight of the crop

The yellow varieties resemble the whites in having a rough-leaved foliage, which they produce, however, in somewhat less proportion. Their flesh is yellow; they grow more slowly than the whites, requiring about four months to become mature; and they produce a root of somewhat greater solidity and higher feeding value They also require rather better soils. Swedes are distinguished from both whites and yellows by the smoothness of their leaves, and by the growth of a neck between the leaves and the root. They have rougher skins, and the bulbs are less rounded and symmetrical. Their production of leaf is also less, and was found at Rothamsted to amount to not more than 10 to 14 per cent of the total crop Swedes grow more slowly than whites and yellows, and require usually one or two months more than the latter to reach maturity. They contain a higher percentage of solids, and they have a firmer flesh, of a yellow colour, which has a greater nutritive value. They are hardier than the other varieties, and keep better, and are consequently better adapted for use in the late spring. They are less exhausting to the soil, and they have greater power to resist disease They require better land than either whites or yellows in order to the production of full crops. In the order of consumption when all the varieties are sown at the same time, the white varieties are most suitable for use in the early autumn, the yellows in later autumn and midwinter, and the swedes in later winter and spring. Of varieties of these various sorts of turnips there is a very large number. In Morton's Cyclopedia of Agriculture, published in 1855, a list was given of eleven varieties of swedes, thirteen of yellow, and seventeen of white turnips; and since that time additions have been annually made to the list by the more enterprising firms of seedsmen, each of which has its own selections, to which special names have been given. The varieties are sometimes classified by the shape of the roots or bulbs, which may be either tankard-shaped or globular, or a modification of these shapes. Varieties with concave tops are to be avoided, as rainwater lies in them and tends to produce rotting of the bulbs Sometimes they are classified by the colour of the upper part of the bulb, which may be either white, green, bronze, purple, or other shade Of standard varieties of whites which have been long grown, mention may be made of the Pomeranian White Globe, introduced from Pomerania about 1830; the Devonshire Grey Stone; the Purple Top Mammoth White, and the White Stone, Stubble, or Six Weeks Turnip, which is a very rapid grower specially adapted for sowing late in the summer Among yellows, Dale's Hybrid, introduced in 1823, and the Fosterton Hybrid have been extensively cultivated for a long period; while the Aberdeen Green Topped Yellow Bullock has for many years been the chief favourite of the east of Scotland and the north of England, and is specially prized for its hardiness and high nutritive quality

Varieties of swedes are divided into Purple Tops, Bronze Tops, and Green Tops. The Green Tops are generally regarded as the slower growing and the hardier, and the Purple Tops as the freer growing and the heaviest croppers The main crop of the country consists of Purple Tops, the varieties of which are very numerous. Many of them appear to be selections from Skirving's Purple Top, an improved variety, still widely cultivated, which was introduced in 1837-8 by William Skirving, a Liverpool seedsman and nurseryman. Many of the selections since put on the market probably excel in merit both that and other standard varieties, but no satisfactory evidence is available as to their relative values

The turnip crop is usually grown after a corn crop, though in a few districts two turnip crops are grown in succeeding years on the same field The tillage required for the growth of the turnip crop is the most complete and thorough given in the whole course of the rotation, and as the seed is not usually sown till about some six or seven months after the previous crop has been harvested, there is ample time given for the various cultivations required to clean the land thoroughly, and to reduce it to the fine state of surface tilth which is necessary in order to enable the seed to be regularly sown and covered in fine earth in which it can successfully germi-

nate. (For particulars of the tillages, see arts. Potato, Mangel, Fallow.) In preparing the land for turnips, such a complete pulverization is given as tends to loosen and open the soil for the whole course of a rotation; while the cleaning operations, continued as they must necessarily be during the earlier stages of the summer's growth of the crop, should also, if properly carried out, leave the land free for years from the most persistent weeds.

The final operation in the methods of tillage followed in Scotland and the north of England is that of setting the land up in ridges, which may be from 24 to 30 in. apart. The standard usually adopted is 27 in., being that required to allow heavy horses to walk freely between the rows without injuring the plants.

In the south-eastern counties of England, and in dry areas on the east coast from Yorkshire southwards, the turnips are sown in parallel rows on the flat, at distances apart varying from 15 to 24 in., but usually 18 to 20 in., instead of on the tops of ridges. It has been found in these districts that the evaporation caused by throwing the land up in ridges dries it so much that the germination of the turnip seeds is prevented, and it is considered safer to sow the seed on the flat surface in which the moisture has been fully conserved. As much depends on the distribution as on the total annual amount of the rainfall; but it is commonly held that where the precipitation does not exceed 24 in. per annum, it is the safer practice to sow the turnips on the flat. But such districts must be regarded as not very suitable for turnip cultivation. Where the average rainfall is so low, maximum crops of turnips will not as a rule be obtained. Where there is no lack of moisture the practice of ridging is found to have important advantages. It collects the finely divided soil immediately under the plants, and their roots extend quickly through the loose and well-aerated ridges. It enables the plants to be sown in more regular rows, and the land to be more easily cultivated during the early growth of the crop. Weeds can be more effectively kept down, and the turnips are kept drier on wet land. Hand hoeing and singling can be done more quickly and cheaply, and also at an earlier period, when the plants suffer less injury from the operation. For these reasons, wherever the rainfall is sufficient the practice of ridging has been universally adopted. When the land has been set up in ridges the turnip seed should be sown at once while the tops still remain moist, but if the land be lumpy a light harrow may be first run over the ridges to throw the lumps into the furrows. The closer the seed barrow follows the ridging plough the better. Delay in sowing after the ridges have been opened is very apt to cause a slow and irregular braird. Swede turnips should all be sown in Scotland during the month of May, but whites, and even yellows, can be sown during the first fortnight in June. The latter half of May is the favourite period. If sown too early the young plants are liable to be damaged by night frosts. In the south of England the month of June is regarded as best, but sowing may be continued up till the middle of July. None may be sown before 23rd May. Early sown turnips in the south of England attain to full foliage about the time of the greatest summer heat and drought, and are then very apt to be destroyed by mildew (see art. Mildew). Late sowing also lessens the tendency of the turnips to run to seed in autumn. On the ridges the seed is sown by a special turnip barrow (or drill) which deposits it in two rows at a time. On light dry soils the seed may be deposited at a depth of 1 in. On wet soils ½ in. is enough. Sometimes light rollers are attached to the barrow which compress the soil on the top of the seed. This is advantageous on light dry soils, but on stiffer or wetter soils the roller should not be used. On the flat the seed may be sown by means of the corn drill specially adjusted or by a special turnip drill, the land being first rolled. Sometimes manures and seeds are sown by the same machine, the manures being sown before and beneath the seed. On very dry soils the manure is sown mixed with water, and the seed is also sown by this water drill. See arts. Drills, Water Drill.

The quantity of seed to be sown may vary from 2 to 4 lb per acre of the smaller seed of the white and yellow turnips, and from 3 to 5 lb of the larger swede seed of ordinary commercial quality. The germination of the seed should always be tested, and if it be of high germinating percentage 1 lb less per acre can be used. Thick sowing is, however, considered safer on clays, on which the turnips braird with difficulty, and it is resorted to also on lighter soils as a partial protection against the 'turnip fly', which in some seasons destroys a large proportion of the young plants. On the other hand, thin sowing economizes seed and has the advantage of giving stronger plants, which suffer less check when they are singled. Should the young plants be destroyed by the fly and resowing become necessary, the ridges should be broken down by the harrow and the drill cultivator, then set up again, and immediately afterwards resown with a thick seeding. Under favourable conditions the seed germinates quickly, and the young plants show in three or four days; and in about three weeks from the date of sowing, if they have escaped the attack of the fly, they should be ready for singling. This stage is reached when the plants get into the rough leaf, and the operation cannot be delayed without injury to the crop. Before the singling is done, the land between the rows is cultivated twice or three times by drill cultivators, by which weeds are destroyed, and the earth is cleaned from the ridges close to the rows of the young plants. The singling is done by hand or by hand hoes. Singling machines have been tried, but none have proved very successful. (See Root Thinners.) When the hand hoeing cannot be overtaken quickly enough they are, however, useful in separating the plants into tufts. All the plants are removed except the strongest single plants, which are left in the rows at distances which are determined by the kind of turnip and the purpose for which it is grown. Turnips intended for market-garden purposes are singled to 6 in. or 8 in. apart only. For ordinary farm purposes the usual distance

apart is about 12 in., but it may vary between 9 in. and 14 in. The closer singling, however, is preferable. With wider singling, larger individual bulbs can be grown in favourable seasons, but the total number is very much less. At 9 in. apart in 27-in. drills the number of bulbs possible is 25,813 per acre, whereas at 12 in. apart it is only 19,360, and the total weight of crop per acre will usually be less. In many seasons the largest sizes of bulbs cannot be grown, and in general it is easier to grow bulbs of medium rather than of very large size. The large-sized roots also contain more water, are less nutritive, and are worse keepers. The larger roots are more exhaustive to the soil because they contain more ash, and they are less likely to be mature when raised. Close rather than wide singling is, therefore, on every ground to be preferred. After the singling has been completed, cultivation between the drills has to be continued to loosen the earth and to keep down weeds, which grow freely between the rows of turnips, and these tillages may be repeated every ten days or so. Some two or three weeks after the singling, the crop must be gone over again with the hoes to clean out weeds that may have grown on the tops of the ridges, and to complete the singling. The cultivation between the ridges must be continued as long as the horses can walk between the rows without doing injury to the growing turnips, after which, on dry land, all tillage ceases. On wet soils the final operation may consist in earthing the turnips up at the sides by means of the drill plough. This keeps them drier, but is otherwise disadvantageous, as it encourages the growth of lateral roots in the bulbs and makes them more difficult to clean when raised.

The turnip crop cannot be successfully grown, unless on soils exceptionally rich in available phosphates, without a direct application of manures. The most common practice is to give dressings of farmyard manure with the addition of some artificials. The crop can be grown on farmyard manure alone, but the practice is not an economical nor a good one. The growth of the plants is slower in the early stages, when rapid progress is most desirable in order that they may escape the 'fly' attack, and that a good yield may be got even in an unfavourable autumn. Moreover, if the dressing of farmyard manure be large, the bulbs produced are liable to be soft and watery, easily succumbing to disease attacks, and bad keepers in winter. A better practice is to give a moderate dressing of farmyard manure amounting to about 10 tons per acre, and to add a small quantity of a readily available phosphatic manure. In good turnip-growing districts this may be of the amount of 5 cwt. per acre of superphosphate, or of a combination of superphosphate with basic slag or bone flour. The addition of nitrate of soda or of sulphate of ammonia will increase the yield of crop; but these manures added to farmyard manure tend to produce soft and watery bulbs, and their employment is probably not profitable. Where farmyard manure is not available, the turnip crop can be grown quite successfully by dressings of artificial manures alone. The most important ingredient of a turnip manure is phosphoric acid, and multitudes of experiments carried out all over the country have demonstrated that on all sorts of soils the application of 4 or 5 cwt. per acre of readily available phosphates will produce a good crop of turnips. The phosphates may best be given in a combination of several forms, superphosphate, with basic slag, or with steamed bone flour, being very suitable. On chalk soils superphosphate alone should be used, and on peaty soils slag or bone flour. On fields liable to suffer from finger-and-toe, the use of the latter manures is also to be preferred. To obtain a full crop, however, the addition of nitrogenous and potassic manures is also necessary. On most soils the latter may be given most effectively and economically either in the form of kainit or of the potash manure salt, which may be applied in a quantity equivalent to 3 to 4 cwt. kainit per acre. On some alluvial soils the potash manures have been found unnecessary, but on all light and medium soils, on peats, and on poor clays they produce a very considerable increase of crop. The nitrogenous manures are somewhat irregular in their effects, varying with the condition of the soil and the nature of the season, but, as a rule, ½ cwt. per acre sulphate of ammonia applied just before sowing, and ½ cwt. nitrate of soda applied as a topdressing after the plants have been thinned, will give a profitable increase of crop. Other nitrogenous manures which may be substituted for these in whole or in part are nitrate of lime, lime nitrogen, and the ammoniacal guanos. A combination of nitrogenous and of phosphatic manures is preferable, in the treatment of the turnip crop, to the use of one manure only of each kind. It is very necessary that the early growth should be forced by the use of quick-acting manures like nitrate of soda and superphosphate, but as the turnip has a long growing season extending right through the autumn, it is desirable also that these immediately available manures should be combined with others of somewhat slower and more prolonged action, like sulphate of ammonia, basic slag, and bone flour. The quantities given of all the manures are such as would be employed in the best turnip-growing districts of Scotland, Ireland, and parts of the north of England. In the south of England, where the crop yields are usually smaller, the manures may be given in less quantity, and superphosphate alone is frequently the only artificial manure employed.

In regard to the best manner of applying the manures, much difference of opinion and of practice exists as to whether farmyard manure should be ploughed into the land in winter or put in the drills in spring just before the seed is sown. (For a discussion of this question see arts. FARMYARD MANURE, and WINTER MANURING.) If the manure be applied in the autumn it should be spread over the surface of the stubble as soon as it has been put out on the field. Too often it is left to sit for a considerable time in small heaps before it is spread, which is a certain source of loss. After spreading, it should be ploughed in with as little

delay as possible. When the farmyard manure is applied in the drills in spring, it should also be covered at once after it is spread and before it has become dry. Any artificials to be given should then be sown on the top of the farmyard manure, and they should be at once covered by closing the drills. When superphosphate and basic slag are both to be used, they should not be mixed, but should be sown at two operations, the one after the other. Nitrate of soda and nitrate of lime may be applied either in the drills or as topdressings after the turnip plants have been singled, the best practice, if no other nitrogenous manure is employed, being to divide the dressing, and to apply half one way and half the other. Should either of these manures be given along with farmyard manure, they should not be allowed to come into direct contact with it, or a loss of nitrogen is liable to take place. Topdressings of nitrogenous manures should be applied immediately after the singling of the young plants. Sulphate of ammonia and lime nitrogen, if used, should be applied in the drills.

The growth of the turnip crop continues into the autumn months, and if the winter be mild may go on till Christmas in the case of late-sown swedes. When fully mature the leaves wither and fall down, and the crop is then ready for raising. White turnips, if sown in good time, may be ready for use in September, and if consumed before they are mature, leaves as well as roots are fed to stock. Yellow turnips will be ready for use in October, and swedes in November. It is the usual practice to raise the swedes in this month in all districts where prolonged or severe frosts are common. On low-lying farms near the sea-coast, or in mild districts where frosts are seldom severe, the crop is frequently left in the field during the whole winter to be raised as required, or to be fed to sheep on the ground. White turnips, if ripe, are easily destroyed by frost, but yellows or swedes are not injured by a moderate frost if not too prolonged. A severe long-continued frost, or a frequent alternation of frost and thaw, will ultimately, however, destroy the whole crop. Various methods of preserving the roots are adopted, of which the most common is to raise and top and tail them, and then place them in large oblong pits in the field, which are covered with loose straw or with a few inches of earth. A better method is to store them in little conical heaps on the field, each heap to contain about two cartloads and to be covered with 3 or 4 in. earth. This involves a considerable amount of labour, but is the most effective method of keeping the turnips sound. In larger heaps or pits some amount of fermentation and heating usually takes place, accompanied by the rotting of some proportion of the roots. This may be partially prevented by leaving the heaps uncovered for some days, and by inserting numerous ventilation pipes along the tops of the pits after they have been covered with earth. A common method of preservation is to cover the turnips in the field by ploughing them in. This may be done by opening a furrow with the single mould-board plough. Two rows of turnips are pulled and set in the furrow, and the ploughed-out soil is ploughed back over them with a deep furrow. When the roots are wanted they are ploughed out again. In this method the roots are kept in a very fresh condition till needed for use, and not much loss is liable to be incurred unless in exceptionally severe winters. There is, however, a considerable amount of labour involved, and there may be additional expense in the extra cleaning required by the ploughed-up roots.

The average yield of the crop is usually put at about 20 tons roots per acre, but there is much variation according to soil and season. In the south of England, crops of 10 to 15 tons are common, while in good turnip districts in Scotland the crops usually amount to 25 to 30 tons per acre. A maximum yield is about 35 tons per acre, which is, however, rarely obtained. The feeding value of the roots is estimated to be about 7*s.* or 8*s.* per ton, while a common selling price in districts remote from city markets is 10*s.* per ton.

The roots are used for feeding sheep and cattle, and to a slight extent as a human food. The turnip when grown in a suitable climate is a healthy crop, but is liable to be seriously damaged, and even totally destroyed, by the virulent fungoid disease commonly known as 'finger-and-toe' (see art. Finger-and-Toe). It is also attacked by various insect pests, of which the most destructive is the 'turnip fly' (see art. Phyllotreta nemorum and others). For costs of cultivation see art. Labour.

[R. P. W.]

Turnip, Garden. The wild turnip (*Brassica Rapa*) is a native of Europe, including, it is believed, the British Islands. The roots were used as a vegetable by the ancients, but only of late years has the value of the green tops been recognized as a substitute for cabbage. Being a biennial the plant takes two years to grow to the seeding state. The best soil for turnips is a light, sandy loam, heavy soils preventing the proper development of the roots and encouraging early seeding. Either organic or inorganic manures may be applied with advantage according to the nature of the soil, the best being farmyard manure, bone dust, and superphosphate. The time for sowing varies between January or February for the late sorts, up to June or July for the autumn or winter crop, the sowing being either broadcast or in drills. Early sowings require to be made in frames or on a warm sunny border, protection being given in severe weather. Turnips grow best when they receive plenty of moisture, and a warm, moist season, with not too many dry, sunny days, is necessary to ensure the roots being tender and succulent. In dry weather they should be well watered. Thinnings should commence as soon as the seedlings are well above ground, the ultimate distance between the plants varying according to the size of root required. As a general rule it is best to leave a space of 4 in. between the smaller sorts, and 6 in. between the larger ones. Frequent hoeing ensures aeration of the soil, and keeps the weeds down at the same time. To store turnips the tops should be taken off and

the roots stored as for potatoes. Turnip tops are the young leaves produced in early spring from roots of the previous year. Some gardeners lift the roots in November and place them close together in a cold frame, where they develop succulent little heads of leaves in midwinter. There are long- as well as round-rooted turnips, the former being little grown in this country, although in favour amongst Continental growers. The best are: White Milan, a small early variety, useful for forcing; Jersey Lily, small, smooth, half early; Late Dutch, late, one of the very best for general use; Red Globe, flesh white, grows well on heavy soils; White Round Eperay, very early, and an excellent keeper; Orange Jelly, flesh yellow and without fibres, turning to a jelly-like mass when boiled

[W. W.]

Turnip and Swede. - Parasitic Fungi.— DECAY OF 'ROOTS' —Finger-and-toe, one of the most destructive root parasites, is dealt with in a special article (see FINGER-AND-TOE). Several other forms of decay, occurring commonly amongst 'roots' in autumn, have recently been traced to the action of certain bacteria and fungi. Frequently the 'roots' appear sound externally, and the mischief only becomes evident on closer inspection. The rots ascribed to bacterial action are as follows: 'white rot', known by the 'root' becoming an evil-smelling mass of soft pulp with a whitish or greyish colour; 'brown rot', with the pulp turning brownish or blackish, but remaining firm to the touch; 'black dry rot' of swedes, with a black or brown cracked and dry cavity inside the 'root'. In each case definite forms of bacteria have been isolated, and when introduced into wounds in sound tubers, the particular disease has appeared.

Another form of root decay in swedes has been traced to a fungus (*Phoma*); the symptoms are loss of the purple colour, followed by cracking of the 'root', the dry spots becoming studded with black points, the spore-cases of the fungus.

Treatment.—Follow the course prescribed for 'finger-and-toe' disease, especially in preventing rotten 'roots' getting into manure and so becoming dispersed from field to field. Since insects and slugs by causing wounds assist infection, any measures directed against them will aid in suppressing bacterial attacks.

LEAF MILDEW. - When the growth of young plants is retarded by dull cold weather or by drought, mildew sometimes appears on the foliage; the Turnip Aphis generally infests the plants at the same time. Two fungi may be present; downy putrefactive mildew (*Peronospora parasitica*), so-called because the leaves generally become discoloured and rot; powdery mildew (*Erysiphe*), which is more likely to appear in dry weather, causes the foliage to become sticky and dusty-like, but without rotting.

Treatment.—Where the crop has not been 'singled', this should be done as soon as possible. No results have been published on spraying, but the spraying mixtures used for the potato crop should check mildew.

Seedlings sometimes damp off when too closely sown, or during wet weather; early 'singling' will check this (see CABBAGE—FUNGUS DISEASES). [W. G. S.]

Turnip, Insect Enemies of.—The chief insect pests of the turnip crop are: *Phyllotreta nemorum* (Turnip Flea), *Plutella maculipennis* (Diamond-back Moth), *Ceutorhynchus sulcicollis* (Turnip Gall Weevil), *C. assimilis* (Turnip and Mustard Seed Weevil), *Meligethes æneus* (Blossom Beetle), *Athalia spinarum* (Turnip Sawfly), *Aphis rapæ* (Turnip Aphis), *Agriotes lineatus* (Wireworm). All these insects, their mode of attack and methods of prevention, are described under their zoological designations. See PHYLLOTRETA, PLUTELLA, &c.

Turnip Cutter, Turnip Cleaner. See ROOT CUTTER; ROOT CLEANER.

Turnip Thinner. See art. ROOT THINNER.

Turnstone (*Strepsilas interpres*), a small species of plover. The general colour of the male in the breeding season is black on the

Turnstone (*Strepsilas interpres*)

breast, and black and chestnut on the dorsal surface, the ventral surface being pure-white. The females, the young birds, and the males in winter plumage are less strikingly coloured. The total length of the bird averages 8 in. The Turnstone is known in the British Isles principally as a spring and autumn migrant, though in Cornwall and on other parts of the south coast they remain through the winter. They breed in arctic and sub-arctic countries, the northward migrations taking place in May, and the southward in August and September. During these migrations many of the birds cover immense distances, for during the winter they extend as far south as the Cape of Good Hope, Australia, and Tierra del Fuego. It is probable, therefore, that some of the birds fly the entire length of the continent of America twice every year. They frequent the sea-coasts, and are seldom to be seen inland. Their name is derived from the curious habit they have of turning over pebbles in search of the insects and other little arthropods to be found underneath. It is a curious and interesting sight to watch them when they are busy feeding. With their quick and active motions, the flat stones and pebbles are seen flying in all directions.

[H. S. R. E.]

Turtle Dove (*Turtur communis*) — This migrant species arrives in April, and leaves in September or later. It is chiefly found in south

and central England, but it ranges to the extreme north of Scotland. Smaller than the other British doves, it can be distinguished by its tortuous flight. The prevailing hue of the plumage is grey, but the back is brown; there is a black-and-white patch on the neck; and white is found on the lower breast, and laterally at the tip of the tail. The beak is brown and the legs are red. Seeds and grain constitute the food, and as these mostly belong to cultivated plants the species is decidedly harmful. The stick nest is constructed in trees rather near the ground, and the two eggs are white in colour. [J. R. A. D.]

Tusser, Thomas (1524 80), a celebrated agricultural writer, was born at Rivenhall, a village in Essex. Commencing life early as a chorister at the Collegiate chapel of Wallingford, in Berkshire, he figures successively as a chorister in St Paul's Cathedral, as a student at Eton and thereafter at Cambridge, and as a retainer about the court of William Lord Paget On retiring from the court he married and settled down on a farm near Cattiwade, in Suffolk. He was not, however, destined for the peaceful enjoyment of an agricultural vocation, and later on we find him serving, now in one occupation now in another, and buffeted about from place to place as the exigencies of life demanded Ultimately he removed to London and died there.

Tusser's famous work, which forms, with his companion work The Pointes of Good Huswifery, his chief claim to the remembrance of posterity, first appeared in 1557 under the title of A Hundred Good Pointes of Husbandrie, and was subsequently enlarged to embrace Five Hundred Good Pointes of Husbandrie This unique work is written in verse, and abounds in maxims and precepts relating to the husbandman's art Every phase of farm practice and rural life is deftly described in his lines, which thus form a valuable source of information on the agriculture and customs of his time. His style is original and attractive. Many practices regarding which opinion differs to the present day, were evidently the subject of discussion in Tusser's time. Thus, thick and thin seeding had their respective advocates, and Tusser rhymes—

'Though beans be in sowing, but scattered in,
Yet wheat, rye, and peason, I love not too thin
Sow barley and dredge with a plentiful hand,
Lest weed, stead of seed, overgroweth thy land'.

With regard to the application of farmyard manure, he enters on even more debatable ground -

'Who layeth on dung, ere he layeth on plow,
Such husbandry useth, as thrift doth allow;
One month ere ye spread it, so still let it stand,
Ere ever to plow it, ye take it in hand'.

As a just and equitable distribution of the produce of the grain harvest, he advocates as follows:—

'1. One part cast forth, for rent due out of hand;
2. One other part, for seed to sow thy land;
3. Another part, leave parson for his tithe;
4. Another part, for harvest, sickle and scythe;
5. One part for plough-wright, cart-wright, knacker and smith;
6. One part to uphold thy teams that draw therewith;
7. One part for servant, and workman's wages lay;
8. One part likewise for fill-belly day by day;
9. One part thy wife for needful things doth crave;
10. Thyself and child the last one part would have'.

He adds—

'Who minds to quote
Upon this note
May easily find enow;
What charge and pain
To little gain
Doth follow toiling plow'.

[J. B.]

Tussoc Grass, a synonym for Tufted Hair Grass (see AIRA). Another Tussoc Grass, *Dactylis cæspitosa*, a native of the Falkland Islands growing in huge clumps or tufts, has been tried in this country as a forage plant, and is also grown for other purposes.

Twist of Intestine.—A frequently fatal termination of colic or gripes is due to twist of the bowel. The muscular coat of the intestine is thrown into spasm, with the result of twisting, looping, and even tying a knot in the small gut which cannot be unloosed, but in the majority of cases leads to obstruction, distension, inflammation, and mortification It is generally believed that some twists are naturally released by the subsidence of the spasm A tradition of the stable exists which forbids the griped animal to go down and roll, lest this accident to the gut should occur The majority of modern veterinary surgeons favour the adoption on the part of the patient of any attitude which appears to give relief, and deem it as likely that a twisted bowel may become undone by such movements, and attribute the twist to the cause above stated, and as having probably occurred prior to the desire to roll (see COLIC) Twist of the intestine sometimes occurs in steers, and is known as gut-tie It is caused by the adhesion of the spermatic cord following on castration, and the looping of the small intestine around it Pigs and puppies sometimes get twisted bowel through the action of large numbers of ascarides in the small gut. Operation offers a small measure of hope, but can seldom be attempted in time. [H. L.]

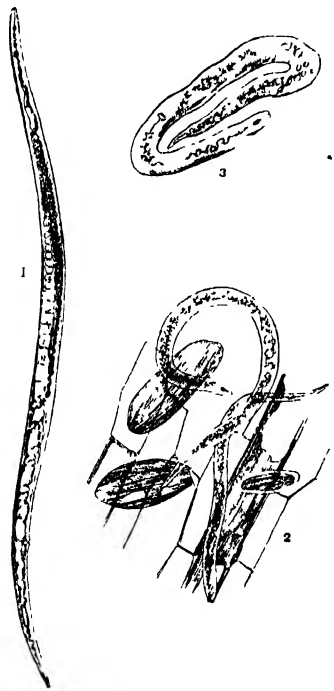
Twitch Applied

Twitch, a useful but much-abused implement for the restraint of horses by compression

of the upper lip, which contains a plexus of nerves, and is therefore highly susceptible to the cord passed around it and tightened by twisting the stick to which it is attached, usually through a hole bored near the end. Grooms should not be allowed to employ the twitch on the ear of a restless horse, and on no account apply it to the tongue, as much cruelty and serious injury have been thus caused [H. L.]

Twitch Grass, a pestilent weed grass on cultivated land. See COUCH.

Tylenchus, a genus of minute worms commonly known as eelworms, and belonging to the Nematoda. The best-known example is



Tylenchus devastatrix (Stem Eelworm)

1. Eelworm. 2. Young form just emerged from egg. 3. Eelworm and egg in plant tissues. (1, much magnified; 2 and 3, more highly magnified.)

T. devastatrix, the stem eelworm, which is believed to be the cause of one form of clover 'sickness', and is certainly the cause of the disease known as 'tulip-root' in oats. The worms seldom exceed $\frac{1}{26}$ in. in length, and they occur in myriads in the diseased stems. Rye, buckwheat, and potatoes are also attacked by them, and they also affect certain bulbs, such as onions and hyacinths. They are found, too, in several grasses. The soil in which diseased plants are growing becomes infected, and the worms, or their eggs, can remain in it for a long time without losing their vitality. They may be carried from field to field in the soil clinging to the horses' hoofs or to the labourers' boots, and even the manure from animals fed upon infested crops may communicate the disease to new areas. In case of attack a dressing of sulphate of potash has often proved beneficial. Other remedial measures are deep cultivation, and a proper regard to rotation, so that no crop subject to the disease shall follow one in which it has occurred without a considerable interval.

T. tritici (= *T. scandens*) attacks wheat, though the disease it causes is seldom serious. It gives rise to the curious galls in the wheat ear known variously as 'cockles', 'purples', or 'false ergot'. On examination these are found to be full of eelworms, and as the galls take the place of grain the yield is diminished. [C. W.]

Tympanitis.—This term is generally applied to a drumlike condition of the abdomen, in which distension of the stomach has advanced until the subject of it is threatened with death by pressure upon the vital organs. Veterinary doctors also recognize a condition of tympany as affecting the intestines or some portion of the abdomen besides or independent of the stomach. In horses, the tympany of flatulent colic (see COLIC) often distends the flank, giving the abdomen an oval appearance. Calves, pigs, and puppies too early weaned, and distended either by fluid foods or wind, are common objects on badly managed farms. For an hour the dyspeptic calf will be seen distended, and before the next meal the flanks will have fallen in and the animal looks hollow. This is not consistent with good thriving, and any disposition to tympany should be treated as a serious matter. Tympanitis of the acute kind in cattle will be found under the heading BLOWN. The reader is also referred to articles dealing with indigestion, impaction, and colic as causes of tympanitis; the malady being a result of disturbed function rather than a disease of itself.

Treatment.—As a rule, a suitable aperient should first be given, and of these castor oil and linseed mixed is the most suitable for calves and older horned stock; castor oil alone for pigs and puppies. Oil has the effect of dissolving or masking gases, as well as gently removing the offending material. In the young a more easily assimilated ration is needed, and smaller meals at shorter intervals. Colts belonging to working dams often suffer from extreme distension as a result of waiting too long and filling themselves too quickly from mares heated by labour. In extreme cases, where life is in danger, the side may be punctured and the gas let out, as advised in the article on BLOWN OR HOVEN already referred to. Chronic tympanitis is evidence of chronic indigestion, and the cause must be sought and removed. It is sometimes discovered after death to have been the result of a foreign body, as a piece of wire or other object immovably fixed in some part of the viscera.

[H. L.]

U

Udal Lands. — Under the feudal system lands are held under condition of fealty or homage to a superior, of which the modern equivalent is a money payment or feu duty As opposed to this, lands are said to be allodial when they are held independent of a superior; and the property in land in Orkney and Shetland, while under Norwegian rule, was free from all burdens analogous to the feu duties or services which were exigible from land in Scotland under the feudal system. The only burden was a government tax called Skat, and an exemption from this tax was given to lands enclosed for cultivation, which were known as *udal* or free lands After the annexation of the islands to the Crown of Scotland in the 15th century, the feudal system was partially adopted, and has gradually to a large extent superseded the old udal holding [D B.]

Udder, Diseases of. See arts MAMMITIS; GARGET; PUSTULATION; WARTS; WOUNDS; TUBERCULOSIS.

Ulcers and Ulceration.—An ulcer is a sore in which there is loss of substance. Wounds represent divided tissues; ulcers are the result of death of tissue. Ulcers may follow on wounds that have occurred in structures indisposed to heal for want of blood supply, as when the cartilage of a dog's ear is injured The friction and dirt which enter a horse's cracked heel lead to ulceration The disease known as occult spavin is due to ulceration of the cartilage within the hock joint. Ulceration of bone occurs when injury and exposure takes place There are specific ulcers of great importance to animal owners, as will be seen by reference to the ulcer of glanders inside the nostrils of horses, the ulcers which result from premature rupture of the pocks of the cow and sheep. The sores in the tongue caused by actinomycosis take on the nature of ulcers A pit or depression is usually seen a ragged margin, and an area within it which has been deprived of more or less normal tissue. A few, with inflamed edges, need poulticing and emollient treatment; but the majority are of the weak or languid type, and require stimulation with constringing or caustic agents varying in strength from alum to nitrate of silver, and including the sulphates of iron, copper, and zinc In a few instances the hot iron may be employed with advantage. [H. L.]

Ulster Large White Pig.—The history of the Large White Ulster pig, which has recently attained to the dignity of a Herd Book, is wrapped up in obscurity. According to information supplied by some of the oldest breeders, the type of pig which prevails in the province of Ulster has been in existence for over half a century, while others assert that it has been bred for a much longer period. However this may be, the variety is so thoroughly established and breeds so true to type that it has every claim to be recognized as distinct.

In appearance the Large White Ulster closely resembles the Large White (York), except that its ears are long, thin, and inclined well over the eyes. The latter is considered a vital point, as it contributes materially to a quietness of habit, and renders the animal peculiarly adapted to field grazing. Another difference is in regard to coat, which is small in quantity, and fine and silky in texture, thereby indicating a thin skin, so much desired by the high-class bacon curer

Owing to its productiveness—the average litter numbering a dozen—and its early maturity, being ready for killing, under normal feeding conditions, when twenty-four weeks old, by which time it weighs about 200 lb. (dressed pork), it is preferred to other breeds by the majority of breeders and feeders in Ulster, who want a quick return for their money.

With the object of effecting, if possible, an improvement in the native stock, the Royal Ulster Agricultural Society, after consultation with breeders and feeders of pigs, and bacon curers in the province, decided in 1907 to institute a Register of the breed, eligibility of animals for registration being for the present determined by the result of inspection made at various centres throughout Ulster at a stated period each year. The natural outcome of this scheme, which has met with unanimous approval and support of breeders, has been a distinct raising of the quality all round, and judging by the enthusiastic way it has already been taken up, there is little doubt that in the near future the breed will undergo rapid improvement, and become, as it is fitting it should, an ideal bacon pig

The standard description and scale of points are as follow

Head —Moderately long, wide between the ears		5
Ears.— Long, thin, and inclined well over the face		6
Jowl —Light		5
Neck —Fairly long and muscular		2
Chest. Wide and deep		3
Shoulders Not coarse, oblique, narrow plate		8
Legs —Short, straight, and well set, level with the outside of the body, with flat bone, not coarse		5
Pasterns —Straight		
Back Long and level (rising a little to centre of back not objected to)		12
Sides —Very deep		10
Ribs.—Well sprung		5
Loin.—Broad		3
Quarters —Long, wide, and not drooping		8
Hams.—Large and well filled to hocks		12
Belly and flank.—Thick and well filled		5
Tail.—Well set and not coarse		1
Skin.—Fine and soft		10
Coat.—Small quantity of fine silky hair		
	Total	100

Objections

Head.—Narrow forehead.
Ears.—Thick, coarse, or pricked.
Coat.—Coarse or curly; bristly mane.

Disqualification

Colour.—Any other than white. [K. M'R.]

Umbelliferæ is the name applied to a natural order of herbaceous dicotyledonous plants easily known by the hollow stem, the repeatedly divided leaves, and by the numerous small flowers arranged as compound umbels. The distinctive features of the flower are its minute petals, not grown together but free, and its ovary on the outside, *i.e.* inferior. When the ovary matures and changes into fruit, it splits lengthways into two dry one-seeded pieces called mericarps, but popularly seeds. The geographical distribution is wide, chiefly throughout the temperate zone of the Northern Hemisphere. In Persia and Tibet many species grow as tall as a man, and yield gum resins useful as drugs.

Agriculturists class the various plants as Cultivated, Weed, Poisonous, and Milk-tainting. The cultivated plants include: (1) root crops, *e.g.* Carrot and Parsnip; (2) leaf crops, *e.g.* Parsley and Celery; (3) seed crops, *e.g* Caraway and Coriander. The commonest annual weeds are. Common Beaked Parsley (*Anthriscus vulgaris*), Hedge Parsley (*Torilis nodosa*), Shepherd's Needle (*Scandix Pecten-Veneris*), and Wild Carrot (*Daucus Carota*), usually biennial. The commonest perennial weeds are. Goutweed (*Ægopodium podagraria*), Beaked Parsley (*Anthriscus sylvestris*), Earthnut or Pignut (*Conopodium denudatum*), and Cow Parsnip or Hogweed (*Heracleum Sphondylium*).

The poisonous plants of dry land are the annual Fool's Parsley (*Æthusa Cynapium*) and the biennial Hemlock (*Conium maculatum*). The poisonous plants of marsh land are. Cowbane or Water Hemlock (*Cicuta virosa*), Water Dropwort (*Œnanthe crocata*), and Marsh Pennywort (*Hydrocotyle vulgaris*). Water Parsnip (*Sium latifolium*) is one cause of taint in milk.

The products of umbelliferous plants are often useful in medicine, *e.g.* dill water from *Anethum graveolens*, and gum resins such as Ammoniacum from *Dorema Ammoniacum*, a native of Persia; Galbanum from certain Persian species of Ferula; and Asafœtida from *Ferula Narthex* of Tibet.

[A. N. M'A.]

Undecorticated Cotton Cake. See art. Cotton Cakes.

Underplanting. See arts. Forestry, Sylviculture, Woodlands.

Underwood. See Coppices; Timber Trees (in law).

Unexhausted Improvements. See arts. Compensation for Unexhausted Improvements; Agricultural Holdings Acts.

United States, Agriculture of.—Compared with Europe and Asia, the United States is a young nation, and the agricultural operations still in their infancy. While development has been rapid and on a broad scale, it has been effected roughly without regard to permanency, without thought as to the effect of the common methods upon the soil, without desire to secure efficiency and quality, and without particular interest in bringing about changes that mean a high state of land culture, the maximum yield of field, orchard, and garden crops, or of the most economical production of animal products.

The wonderful results secured already—the enormous agricultural output, and the gigantic wealth included in the farms, permanent improvements, and annual returns—are due in a large measure to the intelligence of the people, to the original productivity of the lands, to the constant and increased use of tools and machines, to the favourable soil and climatic conditions, to the native plants like corn, potatoes, tobacco, and grasses, so admirably fitted for the uses of farm animals and men, and to the enormous quantity of other earth products like oil, gas, iron, lumber, all of which have contributed to manufactures on a large scale—all of these factors and conditions have entered into the power that has made American agriculture such a vast, valuable, and so notable an industry.

But American agriculture has been of a shifting nature. The early settlers introduced many desirable European plants; they brought live stock from across the waters, and these were raised on every individual farm. As a result, on every farm the entire needs of the home were raised on the holding. The farmer raised not only the raw materials, but manufactured everything for his own use that was called for by necessity. In time this concentrated effort gave way to diversification, and a division of labour resulted. The canal came, soon to be followed by the railroad, and then later by every kind of transportation power. Agricultural industries became segregated or separated or fixed, as the nature of the soil or climate or location demanded

Towns and cities sprang into existence. They called for food, for raw farm materials; and in exchange gave finished products for the home, tools and machines for the farm, and luxuries for the family. From growing every sort of crop, making his own clothing and supplying his own needs, the farmer changed, and gave way to specialization, he cultivated his fields and raised his animals, and from the surplus, after meeting his own needs, he secured his additional supplies from the manufacturing centres of the cities and towns. In time, sections became marked as being peculiarly adapted for certain lines of crop production; and these became centres of supply, giving rise to exchange, not only between town and city, but between agricultural localities also. For instance, sugar cane became a fixture in one section, cotton in another, tobacco in another, corn shifted to the south and middle west, wheat to the uttermost limits both north and west, while live stock settled itself where opportunity showed it the best prospects. Thus sheep departed from New England into Ohio, then into the far west and south-west. Beef cattle sought the rich pasture lands of the middle and western states. The hog followed after corn, and established itself where corn, clover, and alfalfa were most at home. Dairy farmers, mindful of the worth and possibilities of settled communities, congregated around cities and towns, and, undaunted by heat, snow, or cold, or regardless of scant and rocky pasture or diminishing returns in hay and forage, became fixed in New England and the older sections of the country. At the same time, farm poultry, wedded to woman and the home, became a home necessity in every community,

developing all the time until their annual worth in eggs and meat equalled nearly twice the annual gold output of the entire world for a single year.

The American farmer has produced wonderful growth-yields year after year in ever-increasing quantities. He has done so largely because of the extent of his patrimony. He differs in this respect from his brother in Europe or Asia. Were he to secure from his wheat lands an average yield per acre equal to that of England, France, or Germany, he would produce an output equal to that of the entire world at the present day. Consequently farmers of the United States are looking to Europe now more than they have in the past, for suggestions and information on questions that concern a larger average yield and greater net returns.

The Value of Uncle Sam's Farm.—American farms, together with all improvements contained thereon, with crops, live stock, and all other things included, possess a total value of more than $36,000,000,000. During the year 1908 the farmers of the United States produced farm products having a value of more than $8,000,000,000; they received more than $1,000,000,000 for the farm products sent out of the country. Since the farm products imported for the use of the entire nation amounted to but $600,000,000, there remained in favour of the United States a total of more than $400,000,000 as a result of the exchange.

The total value of farm property may be divided as follows. of lands, $25.000,000,000, of buildings, $5,000,000,000; of implements and machinery, $1,000,000,000; of live stock, $5,000,000,000; of products, $8,000,000,000

Ownership of Farms.—The total area of the United States is 1,935,000,000 ac of land. Of this number 850,000,000, or a little less than half, is applicable or devoted to farming operations. This acreage is divided into 5,435,000 individual farms that possess an agricultural population of slightly more than 12,000,000 people. The average number of acres to each farm is 155, or 28 ac to each person included in the agricultural population. Compared with intensive agriculture in other sections of the world, it is readily seen that the United States is well able to support from five to ten times its present agricultural population. There are vast swamp lands that can readily be drained as soon as the need becomes necessary; and wide areas of dry lands, all of which can be irrigated, and thus be made sources of enlargement of farm acreage so as to increase the present acreage by at least 150,000,000 ac., from which can be obtained a corresponding return in yearly products. When these lands are drained and irrigated they will add at least $5,000,000,000 to the worth of the farm plant.

Agricultural Divisions.—The remarkable diversity of soil and climate within the limits of the United States naturally leads to a production of all sorts of horticultural and agricultural products which contribute to the maintenance and comforts of man. The geographical features of the United States are marked by every variety of mountain range, plateaus and valleys, measureless tracts of forest, rivers of unequalled length, and lakes resembling the inland seas of the Old World. But few parts of the country can be regarded as uninhabitable, and territories formerly unpeopled are being made inhabitable by means of irrigation and other facilities offered by modern science. Throughout the United States there has been but one order of things: soils have been reclaimed, cities, towns, and villages reared, railways built, and institutions of civilized life established.

In the course of this article the agricultural divisions as known in common usage in the United States will be followed. The following classification is just one of many commonly employed as the occasion demands: (1) In New England are included the states of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island (2) In the northern states are included New York, Pennsylvania, New Jersey, Delaware, and Maryland (3) In the southern states are included Virginia, North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, and Texas. (4) In the central states are included Ohio, West Virginia, Kentucky, Tennessee, Missouri, Illinois, Indiana, and Michigan. (5) In the western or Great Plains States are included the Dakotas, Nebraska, Minnesota, Wisconsin, Iowa, Kansas, and Oklahoma. (6) In the Pacific and Rocky Mountain regions are included Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, and California

The smallest of the groups is New England, followed in order by the Northern States, Central or Middle States, Western or Great Plains States, Southern States, and the California and Rocky Mountain States. From an agricultural standpoint, the richest, most productive, and those playing the largest part in agricultural production are the Middle or Central and the Great Plains or Western States. These States are all tributary to the Mississippi, with its important branches the Ohio and Missouri rivers In this great Mississippi Valley are the richest lands of the country. Here is the centre of corn and wheat production, of live stock and dairying. Here, too, are the luxurious and abundant pastures on which are grazed immense herds and flocks; here, too, is centred the great body of progressive farmers who stand for the best that is in American agriculture.

Live Stock.—Nearly every country of Europe has influenced the live stock of the United States. Several hundred breeds in all, representing all classes of domestic animals, have been introduced into the United States. In this connection it should be remembered that none of the ordinary farm domestic animals originally existed on the American continent, at least at the time of the discovery of America. The entire stock of horses, cattle, sheep, swine, goats, mules, and poultry were introduced all since America was settled by the early colonists. The early stock gradually spread throughout the settled communities; but little attention in those days was given to either the feeding or

breeding of farm animals, and consequently, up to within the time that improved breeding stock was introduced, the farm stock in America was of very mongrel sort.

From 1800 to 1850 many importations were made of superior-bred animals from various parts of Great Britain and the Continent. These importations have continued until this day; and although American farmers are noted for their skill in preparing various classes of farm animals for the market, they have not been very skilful in the operations and principles underlying the improvement by means of breeding and selection. Within the past fifty years a marked improvement has been noticed in the quality of live stock, but at the present time there is a wide range in value and quality The vast difference in value is due solely to the matter of breeding and feeding. Thus, in one State horses are valued at $41, and in another at $126; in one State the average value of mules is $62, while in another $153; in one State the average value of milk cows is $17, in another $40; stock cattle in one State is averaged at $7, and in another at $23; sheep vary from $1·75 a head in one State to $5·50 in another; and swine from $3 in one State to $12 in another.

These vast differences in respect to value in the different States indicate one of the possibilities before the American farmers. When it is recognized that in no state, even where the highest price is obtained, is the quality what it ought to be in the entire country, it is evident that the total value of farm stock may be readily doubled or trebled. Hence stock-breeding will become a great item on American farms in the future.

Horse Stock.—Among the draught breeds of horses the Percheron is greatly in the lead, both as to numbers and popularity. Other prominent draught breeds are the Clydesdale, Shire, French Draught, and Belgian The Belgian horse is enjoying very marked popularity just at present It acclimates splendidly, is strong, large, and massive—just the sort of animal adapted for the large American farm implements and machines This breed takes well to American pastures and forage crops, and when fed on them, sets a good pace and does a very large amount of work.

Among the coach or carriage breeds the Cleveland Bay at one time was most prominently before the people. This breed, however, has given way to the Hackney and the French Coach breeds. In some parts of the country the German Coach is well liked, but on account of the less uniform grade of offspring the breed has lost some of the popularity that it once had.

The United States Government is now carrying on some breeding operations in the State of Colorado, with a view to establishing a breed of American Coach horses specially adapted to American conditions and environment. This work has been in progress some years, and very gratifying results so far have been obtained. On the plains and in the mountainous districts of western United States there has been bred and raised a mongrel sort of horse possessed of remarkable endurance, but of no uniform type or quality. From some of these were selected foundation stock. Carmen, an American-raised Thoroughbred, heads the stud formed to produce the American Coach horse. This horse, and the mares to which he is mated, have been selected from a point of view of good action, much substance, superior quality, and great endurance. This experiment is being watched with interest throughout the country; and while, if successful, it will not lessen the possibilities of the other breeds, it will contribute to the satisfaction of American horse lovers. In this connection it is to be remembered that the American Trotting horse is purely an American creation. The original blood, of course, was the English Thoroughbred, and by careful breeding and training there has been developed a breed unexcelled by any other breed in any part of the world for speed purposes. The American Trotting horse enjoys a very wide popularity. There is scarcely a community in the entire country that does not possess scores and scores of individuals with the blood of an American Trotting horse running in their veins.

Cattle Stock.—Among the cattle breeds, the Shorthorn is the most popular and most widely distributed beef race of any in the country. The other important beef breeds are the Aberdeen-Angus, Galloway, and Hereford. The Angus has its largest hold throughout the middle section of the country, and has extended its dominion into the Great Plains district. While many Hereford herds are also in this section, they have gone farther down into the south-west into the great range districts; and there the Hereford has been conspicuously successful in improving the common stock of the great cattle ranges. In this same district the Galloways also enjoy a great popularity, because of their hardiness, their ruggedness, and their ability to withstand the hardships of cold and stormy winters. A few herds of West Highland cattle are scattered in various parts of the country, but not in sufficient numbers to influence in any way the general cattle stock of the country.

Among the dairy breeds the Jersey holds first place, followed closely by the Holstein. Both breeds were introduced into the country about the middle of last century, and soon became well known wherever dairy cattle were raised. The number of individuals imported from the Channel Islands and from Holland into the States has been enormous; and so numerous are both breeds to-day, that there is scarcely a section, especially in the eastern half of the United States, where both are not as well known as the old popular Shorthorn. In fact, so numerous are both of these breeds, that there are few people in the country districts who are not familiar with both the name and the breed. The Guernsey is not so well known as the Jersey, but both are popular wherever a rich and choice quality of milk is desired. The Ayrshire also fills an important place in dairy circles, and is best known in the New England States and the State of New York. The cow is very healthy in the American climate, and the

larger quantity of milk she gives over the Jersey appeals to many dairy farmers. The one objection to the breed, however, lies in the smallness of the teat. Milking is done in American dairies largely by men, who object to the small teat.

The Dutch Belted, the Kerry, the Normandy, and Devon, all have their earnest supporters and friends; but these breeds occupy a minor place in live-stock affairs. It is to be said about the Devon, however, that in the early days she was a most popular cow; and it would be impossible to say to what extent land had been broken, forests had been subdued, logs had been hauled, roads had been built, and improvements had been made, through the labours of this English breed. She was not only famous as a milker in the early days, but she was revered as the great draught animal of the country. She has been displaced solely because other breeds, trained and developed to do a more special work, excel her in the production of meat, of milk, and of butter.

Sheep.—Among the sheep breeds the American Merino holds first place. It was the first breed introduced into the United States to any considerable extent, and so long as the wool industry remains prominent, the American Merino will enjoy applause and employment. The breed has gone from the most eastern section to the most western limits, and has travelled from the warmest to the coldest boundaries, and has been at home in each and every district where both wool and mutton are wanted. The forerunner of this breed was the old Spanish Merino; and due to the influence of food, climate, and soil, the Merino has taken on new characteristics fitting the breed better to the work entrusted to it than the old original stock. In the class of short wools, many flocks of Rambouillets and Delaines are also to be found. In the early days, so popular were these breeds that they were raised not only for wool, but for mutton also. As mutton producers, however, they were eventually displaced by those English breeds which were better adapted for the purpose. Of the mutton breeds the Shropshire undoubtedly takes front rank.

After the Shropshire comes the Southdown, Oxford Down, Horned Dorset, Leicester, Cotswold, and Lincoln. Some Cheviots are found, and not a few Hampshires. In respect to the last-named breed, on account of the rangy body, strong bone, and heavy carcass, the Hampshire is more and more coming into popularity. Especially is this true in those States where pastures are abundant and the feed rich and luxuriant. There is a fierce battle now being waged among the sheep breeds, with the mutton breeds in the lead. The Merino is hardly holding its own. With the price of wool going down and the demand for mutton increasing, the tide is turning in favour of the medium wool and mutton type.

Swine.—Among the swine breeds the Poland China doubtless holds first rank. This American breed has been evolved in the great State of Ohio down in the corn-producing countries. Many old European breeds entered into the formation of this particular type, and now for more than fifty years the breed has held an established position. The Berkshire breed is also very popular, and is bred in tremendous numbers. Many American breeders, however, still seek stock from English breeders, and bring back each year many superb specimens; perhaps not superior, but fully equal to any found in America. The Duroc-Jersey, another American-bred hog, is also popular, especially in the middle States, where clover, corn, and alfalfa flourish so well. The breed is prolific, from ten to fifteen pigs to a litter; red is the predominant colour. Their rugged, hardy nature appeals to the western farmer. The Chester White, together with its kin mate the Ohio Improved Chester, is highly appreciated in the eastern States. Both of these are American breeds, one a Pennsylvania product and the other a product of Ohio. During the past few years a demand has arisen for bacon hogs as they are called. This demand has created a sentiment in favour of the Tamworth, the Hampshire, and Yorkshire breeds. While these long have been bred, it is in recent years only that interest and demand have led to the extension of their dominions and numbers.

Considered from the standpoint of the agricultural population, America has four horses to every farm, and less than one horse to every person, there are five cows to every farm, and nearly one to every person; ten meat cattle to every farm, and two to every person; ten sheep to every farm, and two to every person; and eleven hogs to every farm, and more than two to every person. When considered in connection with the fact that a large number of farms and a large agricultural population are devoted to special industries like fruit raising, market gardening, tobacco growing, cotton production, and grain farming, the enormous live-stock output is quickly seen and appreciated.

Grain Crops.—The United States is fortunate in having many grain crops peculiarly at home within her borders. Some of these crops were given to the world for the first time with the discovery of America, and others long known as useful have been transplanted to American farms, where they have secured their widest utilization. Perhaps in America certain field crops have entered more into history-making than elsewhere. It was tobacco in the early days that gave the colonists their first medium of exchange. It was corn that kept starvation away and permitted the successful development of colonies and sections. These two crops are closely identified with the national history. Both are great factors in present-day life and activity, and both are strictly American products. In the same history-making class must be placed cotton, the crop that led almost to the rise of a separate nation, that came nearest to the approach of elaborating a landed aristocracy, and that brought on the greatest war of modern times.

Wheat.—The wheat crop is one of the greatest American crops, winter and spring varieties yielding each year from 600,000,000 to 650,000,000 bus. Kansas is the great wheat state, producing a little less than 100,000,000 bus., or about one

seventh of the entire production of the country. Other large wheat-producing states are Ohio, Nebraska, California, Illinois, Indiana, and Pennsylvania. Scarcely any wheat is produced in New England, but little in the northern states, and a small quantity in the southern states. The wheat area is largely limited to the middle and western states. Wheat has been shifting westward for the past hundred years. At one time this crop was grown throughout the country, but competition has driven the older states out of the business of wheat-growing It should be said, however, on this point, that if the older states have given up the production of wheat, they have done so to their advantage, inasmuch as they have substituted other lines of agricultural effort in its place, like dairying, market gardening, and every phase of live-stock production. The average yield of wheat per acre is very small compared with European countries. It varies, year to year, from 12 to 16 bus per acre This relatively small yield is due to the methods of growing the crop, the idea being to use a large acreage, employ little or no hand labour, so as to secure a relatively large total amount at the least cost per bushel, rather than a large yield per acre at a heavy cost per bushel Consequently, farm implements and tools of every nature are employed in the growing of the crop In many of the large wheat areas the steam engine does all the work of ploughing, preparing the ground, and seeding —all in one operation Wheat harvest is performed entirely by machines manufactured for the purpose. The steam thrashing outfit finishes the enterprise, and leaves the crop in condition to be shipped to all parts of the world

Corn (Maize or Indian Corn) — The great corn crop of the United States is taken from about 100,000,000 ac., the total production being a little less than 3,000,000,000 bus annually. Corn is grown more extensively than wheat, the average being nearly twice as much. It is grown from the east to the Rockies on the west, and from the northern border to the Gulf of Mexico The total value of the crop is about $1,500,000,000 on the average.

The greater part of the corn crop is consumed on the farms where raised, being used largely for the fattening of the various classes of live stock.

In the great corn-growing centres must be mentioned the states of Iowa, Illinois, Missouri, Kansas, Ohio, and Indiana. In the south, while a good quantity of corn is raised, not enough is raised to meet the requirements of southern agriculture. New England raises very little corn for grain, but the silo is very popular for storage and as the means of securing a most excellent feed. This is because dairying is such a large industry in this section of the country, and dairying without the silo is not so profitable.

Associated with corn-growing are the great meat-making industries, hog raising, beef production, and sheep raising. Those states that produce the greatest quantity of corn also produce the greatest quantity of beef and pork. Corn is used for various purposes besides that of feed for farm stock. It is largely in request for the manufacture of starch, while for the extraction of oil and as a human food, sufficient cannot be grown to meet the demands of the market. Indeed, more interest is centred in the corn crop than any other crop grown in the Union. Not only is corn constantly discussed at all agricultural gatherings and meetings, but earnest study is being given this crop in the public schools and in boys' clubs. The latter are now organized in many parts of the country, the aim being the study of the plant that better seed may be secured and larger yields be possible. The impetus recently given this king of all crops will, within the next twenty-five years, probably double its acreage, treble its production, and quadruple its money value.

Oats.—Good farming and broad acreage has made it possible for the United States to produce immense quantities of oats. The acreage of this crop is well distributed throughout all the northern States, the leading ones being Illinois, Wisconsin, Minnesota, New York, Pennsylvania, and Ohio, although other sections of the country give some attention to this essentially northern crop. Even in New England a considerable area in the aggregate is devoted to oats, much of the crop being cut before thoroughly ripe and used as oat hay without being thrashed. The acreage in the United States under the crop does not change very much from year to year, and is close to 30,000,000 ac This is little more than half that devoted to wheat, and less than one-third of that devoted to corn. Measured in bulk, it is about double that of wheat, and one-third of that of corn. The crop varies in production from 700,000,000 to 1,000,000,000 bus. The demand for domestic consumption is always immense, but in years of good-crop production there is a liberal surplus for export.

Barley. — Compared with corn, wheat, and oats, the acreage devoted to barley is small, no more than 6,000,000 being devoted to this crop, from which is harvested from 100,000,000 to 150,000,000 bus. The leading barley states are Minnesota, California, the Dakotas, Iowa, and Wisconsin. In the north-west, along the Pacific coast, a larger acreage is given to barley than formerly. In this section the grain is used largely as a feed for live stock. There it takes the place of corn.

Rye —The total acreage devoted to the rye crop averages about 2,000,000, from which results a total crop of approximately 30,000,000 bus. The leading rye states are Wisconsin. Pennsylvania, New York, Minnesota, and Nebraska. While rye is a stationary crop, it occupies a place of relatively little importance in the country compared with other cereals or with the rye production in Europe. While the supply of rye in the United States is small, it meets all domestic requirements, and under the slightest encouragement a considerable proportion of it goes abroad, although exports are small and unimportant. It is used here largely for supplying the distillers, and is unimportant as a breadstuff.

Rice.—In spite of the fact that rice production in the United States is steadily increasing, immense quantities of this cereal are annually imported. Rice production in the United States is largely limited to Louisiana and Texas. At one time Georgia and the Carolinas produced considerable quantities of rice, but there has been considerable decline in the acreage grown, until now the rice lands of these states are largely abandoned Interest in rice-growing is on the increase in Texas and Louisiana The acreage devoted to rice is about 600,000, from which is taken a little less than 20,000,000 bus., an average of slightly more than 30 bus. per acre. Compared with China, Japan, British India, and other Asiatic countries where rice is the main staple of food, the production in the United States is very insignificant.

American Sugar Industry.—In the United States sugar is obtained from three sources. from the maple groves, from the sugar beet, and from the sugar cane. The maple-sugar crop is of considerable importance in northern New England, Ohio, New York, Michigan, and in parts of other States where the sugar maple tree is a native forest tree. The making of this sugar has been highly developed in the State of Vermont.

The production of cane sugar is confined almost entirely to Louisiana In that State great effort has been made to extend the acreage and to secure more satisfying methods of manufacture. As a result the acreage has increased, and modern machinery has been employed to such an extent that the cost of production has been somewhat reduced.

The sugar beet is by far the most important source of sugar in the United States. The acreage has greatly increased of late, not only in old sections, but also in the new beet-growing sections which have been developed from year to year. Wherever a sufficient acreage and crop can be assured, factories are erected. The States leading in the sugar-beet industry are Michigan, Wisconsin, Montana, Colorado, and California. The sugar beet lends itself to culture on irrigated lands, and returns from such have been very satisfactory. Examples of these are in Colorado, California, and Montana. In Michigan, irrigation is not practised. The land for the crop is prepared by machines, and the sowing is also done by machines. Hand labour is engaged in weeding, in pulling and topping, although machines are now employed to some extent for these purposes.

Lack of suitable help is one of the serious drawbacks to the industry. Foreign labour is largely employed in the beet-growing sections The seed is imported largely from Europe, and a beet with a higher percentage of sugar is thus obtained when such imported seed has been employed. As a general thing, the beet farmer receives from $4 to $5 per ton gross for beets testing above 12 per cent sugar. The production of sugar from cane in the United States runs up to 350,000 long tons, and from beets up to 450,000 long tons.

Potato Crop.—The potato crop is as important in the United States, as it is throughout the world. The annual yield varies from 250,000,000 to 300,000,000 bus. It is quite likely that this crop will increase in amount, since the demand seems to be growing. Among the leading producing States are New York, Michigan, Wisconsin, Iowa, Pennsylvania, Illinois, Maine, and Ohio. Colorado and other western States are devoting more and more attention to this crop. At one time, insect pests caused a great deal of trouble, but these are now easily controlled by proper application of paris green. The greatest menace in recent years has been the blight when climatic conditions were favourable to the disease. Potato rot causes much trouble in many sections. Effort is now being directed to the breeding of resistant varieties that will withstand these two dreaded troubles.

The acreage devoted to potatoes is about 3,000,000 ac. The crop is grown in practically every State in the Union. In the majority of the States the crop is grown simply for home consumption—just enough raised to supply the needs of the household. The average yield per acre runs from year to year between 90 and 100 bus. Starch factories in such northern States as Maine, Wisconsin, and Minnesota use up in the fall the surplus of unmerchantable tubers, thus offering a fair market for a good crop. Much has been said about the use of potatoes in the manufacture of denatured alcohol, but this is still an untried venture.

Tobacco.—Two distinct types of tobacco are grown in the United States, cigar leaf and heavy leaf. Each of these is divided into many varieties. The cigar leaf is grown mainly in Pennsylvania, New York, Wisconsin, in Ohio along the Miami Valley, in New England along the Connecticut and Housatonic Valleys, and in parts of Florida, Texas, and Georgia. The heavy-leaf tobacco States are mainly Kentucky, Tennessee, Southern Ohio and Indiana, Maryland, Virginia, West Virginia, and the Carolinas. Heavy-leaf tobacco is used chiefly in the manufacture of cut, plug, and smoking tobacco, also snuff, and is largely exported.

The cigar-leaf tobacco is used in the States mainly for the manufacture of cigars. The consumption of the latter has increased in a decade almost by 25 per cent. For generations, the Connecticut valley of New England has been famed for turning out some of the finest wrapper leaf that is put in domestic cigars. However, during the past decade the choicest wrappers have been produced in Florida and Georgia, where a superior type of Sumatra tobacco is grown under shade. Each year there is imported annually into the United States from 6,000,000 to 7,000,000 lb. of Sumatra leaf from the Dutch East Indies The total production of tobacco is about 70,000,000 lb.

Cotton Raising.—The 'cotton belt', in which three-fourths of the world's supply of cotton is grown, lies a little below latitude 37 degrees, extending from the Atlantic on the east to Texas and Oklahoma on the west. A line drawn from Norfolk (Virginia) to Cairo (Illinois) just about marks the northern limit for profitable cotton culture in the United States. In this area there is neither uniformity of climate nor of soil, yet

cotton predominates; and to-day cotton is a more powerful monarch than ever.

While other crops are gaining in prestige and favour in the southern States, there is no prospect at all that cotton will decline one whit in power or influence.

The climatic conditions in the cotton belt are as follows: a relatively high temperature, a long growing season, a moderate and well-distributed rainfall throughout the growing season, a minimum of rainfall at harvest time, and a great deal of sunshine. It is a singular fact, but worth mentioning here, that cotton, although a native of the Tropics, is at its best in the more temperate climate of the American cotton belt.

The acreage devoted to cotton is between 30,000,000 and 35,000,000 ac., from which are produced 12,000,000 to 13,000,000 bales, worth from $500,000,000 to $600,000,000. The selling price varies from year to year. It has been estimated that in the United States there are at least 100,000,000 ac. available for cotton, from which 50,000,000 bales could be secured.

Hay and Pasturage.—The grass crop of the United States is the largest in acreage of any crop grown In value it ranks first also. The part of it that can be cut and cured into hay comes in the list as fourth in value of crops produced. Because of live-stock interests, the hay crop is of very great commercial importance in every section of the United States. That part of the grass crop devoted to mowing is from 40,000,000 to 50,000,000 ac. annually. The average yield per acre has always been low, not more than 1½ ton. A decided improvement has been noted in this direction within the last fifteen or twenty years, due to increased attention to the crop, better preparation of land, more frequent rotation of crops, and to more attention to fertilization.

Timothy is the standard in most markets, and is the class of hay most largely handled, although, in the west, large quantities of prairie hay, alfalfa, and more recently considerable quantities of mixed hay, enter the market. The great hay States are New York, Pennsylvania, and the middle States, with Kansas added. The acreage devoted to the hay crop in New England is large, but even then is only slightly greater than that produced in Pennsylvania. Clover hay, while it does not enter largely into commercial sales, is an important crop in the central and middle States. It is consumed largely on the farms on which it is grown. In the southern States, cowpea hay has now come into favour, there being few southern farms on which this crop is not grown. It is valued both for food and as a soil renovater. Timothy does not do well in the cotton States, and the same objection has been raised against clover. To some extent, crimson clover is used in the south. Japan clover is popular in the south; not as a hay crop, however, but as a pasture crop.

The crop most continually in the public eye at present is alfalfa. The most astonishing results have been secured from this crop in the Great Plains States like Kansas, Nebraska, Missouri, and further east in such States as Illinois and Iowa, somewhat in Ohio, and in the far western States of Colorado, Utah, California, where irrigation is practised. Within the last few years, mills have been made for the purpose of grinding alfalfa hay into meal. Although still in its infancy, this undertaking has developed into a very large business enterprise. As a result, from the great alfalfa regions hay is now made into meal and sent into all parts of the United States.

Throughout the middle and central States timothy and clover are the great pasture crops, and both enter into the system of crop rotation. Red top is popular for New England pastures and meadows. In many sections cereal hays are in favour—oats and vetch in the south, and oats and Canadian field peas in the north. The latter crop is grown in the northern sections especially as a soiling crop to be fed to dairy cows.

Fruits. — The list of fruits grown in the United States is large. It is a common custom throughout the States for each farmer to own his own orchard, in which are grown common orchard fruits like apples, peaches, pears, plums, cherries, and grapes. The common garden or bush fruits also find place in most country gardens, although these do not occupy a place equally important to the orchard fruits.

It is to be said also that the production of orchard fruits has in recent years outgrown the limits of small farm orchards. Now fruit raising is an industry by itself. In some sections, particularly in New England, farm orchards from 1 to 10 ac. are common, and a few large commercial orchards have been established. However, the commercial crop belongs rather to the west and south. Connecticut, New York, Ohio, Georgia, North Carolina, Arkansas, Texas, Missouri, and Tennessee are the most conspicuous examples in which the large commercial feature has been introduced and developed. In Georgia, Texas, and Arkansas, very large fruit plantations have been established, from which fruit is sent to all of the leading centres of population Increased facilities for transportation, cold storage, and refrigeration have so encouraged the industry that the returns now stand as follows. Apples, 195,000,000 lb.; peaches, 17,000,000 lb.; pears, 7,000,000 lb.; plums and prunes, 9,000,000 lb ; cherries, 3,000,000 lb.; apricots, 3,000,000 lb. The grape industry is not at all a small one, the production being 1,500,000 lb. as a general average.

From these figures it will be recognized that the apple crop is of more importance than all others combined. While considerable care has been given to the storing and marketing of apples, but little attention is given during the period of growth, and fungus diseases and insects are most conspicuous. As a result, while millions and millions of bushels are produced, the proportion placed in winter storage is ridiculously small. The principal commercial varieties of apples in the middle and western States include the Baldwin, Greening, Northern Spy, and Spitzenberg. The Ben Davis, for a long time immensely popular in the south-west, is now receiving more attention in new plant-

ings of commercial importance in the north and east. This apple is one of the easiest to keep, and its bright-red colour makes it an attractive seller. In quality, however, it is the most inferior of all. The consuming public, in cases where the apple is known, are not inclined to favour the Ben Davis.

Apples are receiving much attention now as a crop for old worn-out lands and in the more mountainous and hilly sections. The most famous apple regions are in western North Carolina and eastern Tennessee, the Ozark Mountains in Arkansas and Missouri, throughout the northern part of New Hampshire and Maine, and in all sections of New York.

The largest commercial peach regions are in Georgia, Connecticut, and Texas. The prune crop is largely developed in California. In this State, also, various kinds of grapes are grown to their highest perfection. In the regions of the Great Lakes, great quantities of grapes are also grown. The native grapes in North Carolina and Virginia are very popular for local consumption and for the making of choice wines.

Tropical fruits have a very limited area, Florida and California leading all other States in their output of oranges and lemons. The pineapple and grape-fruit crops of Florida are considerable. These fruit products are rapidly sent out in all directions, so that at all seasons more or less of each is to be found upon the markets, not only in large cities but the remotest villages and towns.

Vegetables.—Much that has been said in reference to the farm orchard can be said also of the vegetable garden. The farm garden is so closely identified with the farmstead that farming in the United States would not be considered complete without the popular farm garden. So strong is its hold upon people, that even those in suburban towns and villages find recreation and profit in growing vegetable crops for both home consumption and local markets.

With the improvement of transportation facilities, commercial 'trucking' or market gardening has assumed gigantic proportions within the last twenty-five years. The large commercial gardens and trucking enterprises near large cities have been unable to supply the demand. As a result, a call has gone to every suitable section where soil and climate are propitious, for immense quantities of garden crops. Consequently, from the south and middle west, train-load after train-load of all kinds of garden crops are dispatched into the larger cities. These consignments include potatoes, onions, celery, peas, beans, cabbages, beets, corn, all sorts of melons, and all other garden crops of every description. Trucking soils usually selected are those naturally light in texture, rich in vegetable matter, sandy in nature, easily cultivated, and in sections where a good deal of rainfall is prevalent and where the winters are mild. Such conditions are found all along the Atlantic sea-coast from Virginia to Florida. This section is one of the most conspicuous centres where specialization has been made. Here all garden crops, small fruits, strawberries, and a score or more of popular products are grown and sent to all parts of the north and west.

In recent years Texas and Oklahoma have been opened up, and out of the former, especially, large quantities are sent into the central regions of the United States, and often even into the northernmost parts. The famous Rocky Ford canteloupe is sent from Colorado and dispatched to all parts of the country. This is a conspicuous example of soil, crop, and climate all being in harmony to produce a product of the highest quality.

Another example of the highly specialized market crop is the cranberry. The most important cranberry regions are in the neighbourhood of Cape Cod, Massachusetts, in New Jersey, and in Wisconsin. More than 1,000,000 bus. of this crop are annually raised in the United States. The price per bushel varies from $2 to $3.

The onion crop is also an important one. Most of the onions for autumn and winter use are grown in New York, Massachusetts, Ohio, Michigan, and Indiana. Other States coming into prominence in this line are Texas, Illinois, Wisconsin, Minnesota, and Iowa. Connecticut was at one time a very large producer, but in recent years interest in the crop has somewhat flagged. In favourable years 600 bus. per acre may be harvested, although occasionally yields varying from 800 to 1000 bus. per acre are secured. The annual crop runs from 3,000,000 to 4,000,000 bus., and sells from 75 cents to $1·50 a bushel.

Dairy Industry.—At the present time 20,500,000 milk cows are in the United States. From these are produced 35,000,000,000 qt. of milk, which, valued at 2¼ cents a quart, means to the farmer $825,000,000. The effort on the part of dairy farmers, dairy schools, and the agricultural press is along the lines of larger production by better methods of feeding and handling dairy herds; of better methods in caring for the milk; of more skill in manufacturing dairy products, of increasing the efficiency of dairy herds by selection; and of greater skill in the breeding of dairy stock.

Laws designed to preserve and protect the dairy business have been enacted in nearly every State, and all interstate commerce matters are regulated by carefully-drawn and stringent dairy laws enforced by the Federal Government. While co-operative creameries have been established in many States, as well as independent butter factories and skimming stations, the greater part of the butter manufactured is done on the farms, as indicated by the fact that now 1,250,000,000 lb. of butter are made annually on the farms, while but 450,000,000 lb. are made in creameries and butter factories. In this connection it should be said, however, that only about one-half of the farm-made butter is sold, the other half being consumed in the farm homes; consequently the receipts from the sale of butter are about the same from the two systems. The annual production of cheese in cheese factories is 300,000,000 lb., but a very small quantity of cheese is made on the farms. The leading dairy States are New

York, Pennsylvania, Illinois, Wisconsin, and Ohio.

Poultry Industry.—One of the largest side lines of the agriculture of the United States is the raising of poultry products for market. The value of the annual poultry crop is on an average about $600,000,000. Poultry raising for meat, eggs, and feathers is not only one of the most popular and universal, but also one of the most profitable adjuncts to farming. Fowls of every sort are to be found on nearly all farms, north, east, south, and west.

The poultry industry of the United States has exhibited marked expansion during recent years. This is due to several causes, chief of which may be mentioned the rapidly growing population of the big cities, development of local markets, better storage facilities for keeping both eggs and dressed poultry, and the increased consumption on the farm. The perfection of refrigeration service has almost revolutionized the handling of dressed fowls, turkeys, chickens, and ducks, hundreds of thousands of pounds of these annually being put in coolers and sold from time to time when demand calls for them. Broilers are put into refrigerators in the middle west largely in July, August, and September; roasting chicken from September to December, and turkeys in December and January. Often fowls are held in storage several months, but there has been a persistent agitation in various sections against the keeping of undrawn poultry in storage. This has led to legislation against the practice in some States. The entire business of poultry raising has been constantly increasing, due to the development of suburban homes, to the establishment of poultry farms, large and small; to the instruction given in agricultural schools and colleges; to the promotion of the industry by the poultry and agricultural press; and to more concrete knowledge of methods of growing and handling poultry, given out by the agricultural experiment stations.

Agricultural Education.—There are nearly 100 schools of agriculture in the United States, 10 of these are for coloured students. In many of these schools or colleges are to be found correspondence departments that give systematic instruction about the common affairs of the farm. In connection with nearly all of the colleges, agricultural experiment stations have been established. Both the colleges and experiment stations are co-operating with other educational efforts and movements in seeking to standardize and build up country-life education. Agricultural extension departments in the agricultural colleges work in conjunction with farmers' institutes, various kinds of boys' and girls' clubs, township high schools and granges, for the promotion of agricultural college training; men have gone out to all parts of the country advocating the teaching of agriculture in the schools, and demonstrating how it can be done. In many States the teaching of agriculture in the schools is now required by legislative enactment. The southern States have been leaders in this work, and by legislative enactment agriculture has been made a required study on a par with reading, arithmetic, history, and geography. The farmers' institute movement, begun in Ohio about twenty-five years ago, has now expanded until it has become a part of the life of every agricultural community.

The farmers' institute has been called the great farmers' school in America. To it each year many thousands of farmers in the several States go for a day or a week's instruction and training. From 50 to 250 institutes are held each year in the various States. This work is promoted by the respective States, being largely in the hands of the State agricultural departments. The great advance that has been made in the way of agricultural education has been largely the result of the agricultural experiment stations, 56 of which are now supported in the United States. Until this movement was started in 1888, farming was largely a matter of guesswork, with unreliable facts for guidance and no literature for improvement. Since this work was begun, a very creditable list of books, agricultural papers, and from 200 to 300 annually prepared bulletins giving the results of accurate experiments, are now available to farmers. Thus the present-day farmer has at hand the most up-to-date information to steer him straight and safe in his farming operations.

In addition to these educative influences must be mentioned the agricultural press, with a total number of between 400 and 500 publications, representing a circulation of more than 15,000,000. Among this list of leading agricultural papers closely identified with agricultural progress are: American Agriculturist, Orange Judd Farmer, New England Homestead, Breeders' Gazette, Hoard's Dairyman, the Progressive Farmer, Farm and Home, Wallace's Farmer, and Country Life in America. [C. W. B.]

Unit Values of Foods and Manures.—The valuation of foodstuffs and manures according to the percentage analysis of their valuable ingredients is described in the articles Feedingstuffs, Valuation of, and Manures, Valuation of.

Unsoundness in Animals.—The importance of soundness in animals should be obvious to all who own or use them, but there is unfortunately some indifference still displayed on the part of those whom it most concerns, namely the small holders. An unsound sire is dear at any price, and unsound cattle are seldom worth their keep. It costs no more to maintain a sound pedigree animal than to keep a mongrel; nay more, it is abundantly proved that it costs less to feed the best stock, because they have acquired greater powers of assimilation, and profit more by the ration than common-bred animals. The best of judges, with skill in selection, are the most willing to employ the veterinary surgeon to examine as to soundness before completing a purchase; and contrariwise, those with least knowledge are the most self-confident.

Soundness in horses has been variously defined; but an exact definition is difficult, because an animal may be sound for the purpose for which it is sold, but not for other uses. For

example, a mare in good health and free from hereditary defects may be lame as the result of an accident, but sound for the breeder whose only object is to obtain a foal. Baron Parke, in giving judgment on the subject, said. 'The word 'sound' means what it expresses, namely that the animal is sound and free from disease at the time it is warranted to be sound'; and Baron Alderson says (Kiddell *v.* Burnard). 'With regard to the word 'sound', the only qualification of which it is susceptible arises from the purpose for which the warranty is given'. Again, unsoundness has been held to be 'anything which does now or may hereafter interfere with the usefulness of the animal'; but such a definition is scarcely fair to the vendor, who may be selling a mature horse with a round splint well placed forward and not likely to cause trouble, but a blow upon which might excite a fresh growth and resultant lameness. We have therefore to bring to bear practical knowledge and experience, and, like actuaries, form an estimate of the probable average risk entertained in regard to some imperfections, or we should never 'pass' a horse at all, if insisting on perfection and legal soundness.

There are a number of defects which are clearly recognized as unsoundness, and we may briefly state them, but with certain reservations A horse may be in perfect health bodily, and his action or motion of all his limbs be correct, but have been unnerved; and such an animal is unsound. See NAVICULAR DISEASE and NEURECTOMY.

Blindness is unsoundness.

Cataract, however small.

Bog spavin is generally caused by hard work, and when pronounced constitutes unsoundness; but a little fullness at the seat of bog spavin would not be sufficient cause for rejection Broken-down tendons constitute unsoundness, although they may have fined again.

Broken knees may or may not come under the description of unsoundness, as the injury may be quite superficial and no more than a skin blemish, or it may have been of such a nature as to cause binding and loss of mobility to the joint, and consequent increased danger of falling again. Veterinary examiners usually 'mention' a chipped knee, but do not condemn the subject of it as unsound

Colds.—Many young horses offered for sale in markets and fairs suffer from catarrh, and while so afflicted are unsound; but, confident in the temporary character of the ailment, the vendor will warrant, or the examiner pass as sound, subject to a special cover or guarantee in respect of the cold. This practice is a convenient one, as facilitating business without imposing an unfair risk on the purchaser, or doing any injustice to the vendor, who rarely hears any more about the animal, but who makes himself responsible in the event of the cold leading to some defect of the wind.

Coughs are more serious than common catarrh. As this symptom may arise from a great variety of causes, the animal should be rejected as unsound, or covered by special warranty extending over a longer period than would be reasonably expected in the case of a common cold. As a cough may supervene within a few hours of purchase, it is important to ascertain if it existed at the time; otherwise the buyer must keep the animal with all faults and errors of description, if purchased at an auction sale.

Capped Hocks and Capped Elbows, Capped Fetlock or Timber Leap.— These unsightly enlargements are not deemed unsoundness so long as they do not give rise to lameness or decrease the mobility of joints.

Contracted Foot.—In itself, an 'odd' or contracted foot is not necessarily a sign of unsoundness, as many horses, especially Thoroughbreds, have a narrow and upright foot without navicular disease; but contraction should be regarded with suspicion.

Rings on the Hoof.—These represent periods of accelerated growth as a rule, such as may result from turning out to grass, or from blisters applied to the coronet. Only the rings characterizing laminitis constitute unsoundness (see LAMINITIS).

Curb and Curby Hocks.—A distinction is made between hocks with a slight prominence in the seat of curb, and the presence of curb itself A High Court decision was in favour of the defender who had sold a curby-hocked animal. Curb constitutes unsoundness

Cutting, Brushing, Speedy Cutting — These defects of action, or results of bad shoeing or driving, are not deemed unsoundness unless the horse is lame at the time of sale. The present writer would, however, take exception to some cases, in which the malformation is certain to lead to trouble—particularly in the case of speedy cutting, although due to conformation and not what is accepted as disease.

Soreness of the joints is not considered unsoundness, as it is the effect of overwork and likely to pass off.

Splints – In mature horses, and not in a bad situation or causing lameness, these are not deemed unsoundness.

Thoroughpin of only slight extent is usually passed by an examiner; but where it is marked and prominent it is a disqualifying infirmity, and should be deemed unsoundness.

Thrush, when not of a serious nature, and apparently due to neglect, does not constitute unsoundness.

Windgalls, unless very large and sensitive, or causing lameness, are not deemed causes of unsoundness.

Corns, unless superficial, constitute unsoundness.

Farcy. — Evidence of farcy is taken to be unsoundness

Fever in the feet, or laminitis, renders a horse unsound.

Glanders is unsoundness.

Grease is deemed a cause of unsoundness.

Mange constitutes unsoundness.

Megrims, or any kind of fits, render a horse returnable as unsound.

Navicular disease is a cause of unsoundness.

Nerved or Unnerved.—A horse that has undergone this operation is unsound.

Ophthalmia is unsoundness.

Ossification, whether of the joints or lateral cartilage (sidebone), constitutes unsoundness.

Pumiced foot or dropped sole is evidence of laminitis, and a horse so affected is unsound.

Quidding.—This evidence of imperfect mastication is unsoundness.

Quittor renders a horse unsound, and commonly lame.

Ringbones and sidebones render a horse unsound

Roaring and whistling and thick wind are causes of unsoundness.

Ruptures constitute unsoundness.

Sandcrack.—This defect constitutes unsoundness.

Seedy toe is unsoundness.

False quarter constitutes unsoundness.

Spavin renders a horse unsound whether lame or not.

Strangles render a horse temporarily unsound; and on account of the risk of wind defects which may follow, such a one is deemed unsound, although perfect recovery is the rule.

Stringhalt is a form of unsoundness.

Thickened back tendons or ligaments constitute unsoundness.

Most of the causes of unsoundness hitherto mentioned are such as affect the limbs and feet, and constitute the majority The exceptions (glanders, farcy, eye and wind troubles) can be detected by the expert veterinarian, but there are other causes of unsoundness beyond his power to discover in the course of an ordinary examination. The animal may be the victim of kidney disease, of megrims, or colic, have a degenerate liver, or be subject to retention of urine, or diabetes, or have brain tumour. Many horses with such serious forms of unsoundness are sent to auction sales, and the majority pass through the period of probation without displaying their defects. A warranty of reasonable duration should therefore be asked by the purchaser, and given by the vendor A month is the accepted term in Scotland, but in England a warranty endures 'for ever' unless specifically stated.

Besides the many causes of unsoundness there are tricks or 'vices' so called, which entitle a purchaser to rescind a bargain, such as biting, bolting, crib biting, kicking, rearing, restiveness, shying, and weaving. At fairs and markets a period of eight days is generally recognized as sufficient for a fair trial, and the return of a horse after that lapse of time is not likely to be accepted. The value of a warranty, whether as to soundness or suitability for the purpose required, depends upon a variety of circumstances; as, for instance, if a curb is recognized, but the purchaser takes the animal despite it, and on the recommendation of the seller, he has lost a remedy against the vendor unless lameness results within the period of warranty. The word 'warranted' should always precede all others. Although a warranty may be a verbal one, there is a distinction between recommendation and warranty, and the latter should therefore always be given in writing. Objection should be made at the earliest possible date, and expert evidence obtained without delay.

Warranty of soundness in respect of cattle, sheep, and pigs is seldom asked where pedigree animals of no special value are concerned; but soundness is of great importance whether to the breeder, the dairyman, or the butcher, the grazier, or the ordinary farmer. When a fat beast or sheep is sold to the butcher, it is assumed that the animal is sound and fit for human food when killed; but the law is very unsatisfactory, and the farmer who merely 'believes' the animal to be sound can seldom be made to share the loss, or pay for a carcass condemned at the abattoir or public meat market by the inspector appointed. A mutual insurance fund has been tried with more or less success at different places, but farmers have hitherto been rather unwilling to contribute their share. If a butcher's beast is sold as sound, it must not prove tuberculous, or in any way 'unsound and unwholesome and unfit for human food'. The breeder buying a bull will have the same right to expect the animal to be in perfect health and free from undiscoverable disease such as incipient tuberculosis. He will also be entitled to one that is perfect in all his parts and not impotent when required for service. The dairyman who buys cows as sound should not only have them free from constitutional diseases, but with udders and teats in perfect working order. If a blind teat or lost quarter is discovered, the animal is unsound as a milch cow, although such a one might be sold to a grazier to fat off, or to a butcher, if already fat, for the purpose of slaughter. A warrant applies to other matters besides soundness, as when a cow is sold as stocked at a certain date, and is found to be 'empty' or not in calf; and the same may be said of ewes that are sold as being tupped, or sows as being in farrow. Honest mistakes are made, of course, in connection with pregnancy, and the question of special warranty is rather outside the present article; but a ewe or a sow would not be deemed sound if one quarter of the former's udder was lost, or several teats in a sow were useless for suckling pigs. When a ewe flock or a sow is sold, there is an implied warranty of soundness for the specific purpose for which the animals were purchased; but, as stated in connection with horses, a written warranty of soundness is the most satisfactory method of dealing. The grazier purchasing barreners or store stock is entitled to constitutionally sound animals that will answer his purpose; and may return, or claim compensation, where it can be proved that they were not sound at the time of sale. *Caveat emptor* is still a good motto for the market; and a prompt settlement of disputes as to soundness, by mutual consent, may be recommended rather than litigation.

[H. L.]

Urea, or **Carbamide,** is a white crystalline substance soluble in water; chemically it is the diamide of carbonic acid, and has the formula $CO(NH_2)_2$. It is the chief nitrogenous waste product of the animal body, being excreted in the urine by the kidneys. The amount occurring in urine is variable—fresh cow's urine in summer may contain about 4 per cent. Certain bacteria (e.g. *Micrococcus ureæ*) readily bring

about fermentation of urea with the production of ammonium carbonate, and hence in old urine or in the drainage from manure heaps there is practically no urea.

Urea is historically interesting as being the first undoubtedly organic compound prepared in the laboratory—by Wohler in 1828. [H. H. G.]

Urine is the liquid excrement of the animal body, and contains in solution the nitrogenous waste products and soluble mineral salts derived from the *digested* food and the breaking down of tissue. Normal urine is transparent, but on standing becomes cloudy owing to the deposition of substances such as mucus, and urates of sodium, potassium, and ammonium. The chief manurial constituents are potash and nitrogen. In herbivorous animals the urine is generally alkaline, and therefore, since phosphate of lime is insoluble in alkaline solution, unless lime be absent there will be no phosphate in the urine In general, most of the phosphate, lime, and magnesia are excreted in the solid excrement or dung along with the undigested nitrogenous constituents of the food, while most of the potash and nitrogen appear in the urine As these latter are most expensive to buy, the importance of conserving the liquid portion of farmyard manure is evident (see under LIQUID MANURE and FARMYARD MANURE).

Both composition and quantity of urine vary greatly with the age and kind of animal, the food, the amount of exercise, and the quantity of water taken. It is therefore impossible to represent the composition of urine accurately, but the following figures serve to indicate the average percentage composition of urine of different animals, with respect to the manurially important constituents:—

Animal	Horse	Cow	Sheep	Pig
Water	90 0	91·5	86·5	97·6
Nitrogen	1 52	1·05	1·31	0 50
Phosphoric acid	trace	trace	0 01	0·14
Potash	0·92	1 36	trace.	0 70

The immense effect of the character of the diet and the amount of water consumed may be illustrated —

COWS FED ON MANGELS, AND ON LUCERNE HAY

	Mangels (88 lb)	Lucerne Hay (14 lb).
	Urine passed per day	
Percentage of water	95 94	88·23
,, ,, nitrogen	0 124	1·540
,, ,, phosphoric acid	0 011	0·006
,, ,, potash	0 597	1·690

The nitrogen in urine occurs chiefly as urea, creatinin, and hippuric acid; also as uric acid in the excrement of birds, of man, and of the carnivora (whose urine is acid). In the soil all these are rapidly rendered immediately available for plant requirements. In its first year of application, therefore, farmyard manure tends to have the characteristics of sulphate of ammonia or nitrate of soda application, in its effect upon form, time of ripening, and quality of crop —thereafter the residual effect, being derived from the slow decomposition of the insoluble forms occurring in the solid excrement, is spread out over a number of years

The urine of young growing animals and of milking cows is least rich, part of the manurial constituents of the food going to animal increase or to milk production. Fattening stock whose increase is chiefly fat which contains no nitrogen, potash, or phosphate, yield a richer urine; while adult horses void, either in the urine or the dung, practically the whole of the mineral matter and nitrogen consumed in the food. All the nitrogen of the *digested* albuminoids of the food appears in the urine, and hence the richer and more digestible the food the richer the urine In the dung-heap the urea-nitrogen of urine is rapidly converted into carbonate of ammonia by bacterial agency; and unless precautions are taken to prevent volatilization of this compound, serious losses may occur. [H. H. G.]

Urine, Retention of.—As many serious consequences ensue on undue retention of the urine, persons in charge of animals should afford them every opportunity of passing it. The more highly organized animals will not attempt micturition under unfavourable circumstances Horses, as a rule, must deliberately adopt a convenient posture before they can obtain relief Compulsory retention, whether brought about by restraint, by occlusion of the canal by calculi (see CALCULI, and BLADDER, DISEASES OF), by spasm of the neck of the bladder (see COLIC), or other diseases, as morbid growths, causes the viscus to fill and become so distended that the muscular wall loses its contractility and is for the time paralysed. The urine is sometimes unduly retained through systemic diseases, as in so-called milk fever of cows The prominent symptoms are those of straddling of the hind legs, frequent extrusion of the penis and equally rapid withdrawal; in horses, colicky pains, dribbling of a few drops, or an intermittent flow. *Treatment* consists in affording perfect quiet, a suitable box and loose litter, unloading of the rectum by hand and gentle pressure upon the bladder, and if these fail, the passing of a catheter. The latter operation cannot be performed in the bull. Small animals, as dogs, may be given a hip bath of warm water. [H. L.]

Uterus, Eversion of, a frequently fatal accident following on parturition. In order of frequency among the species of farm animals, the ewe, the sow, the cow, and the mare stand related. It is generally said that eversion or expulsion of the uterus is the result of prolonged labour, but it frequently happens after the easiest of parturitions in cows, ewes, and sows; it would sometimes seem to be due to great relaxation of the parts, and feebleness of the uterine ligaments. In the larger animals the great volume of the uterus presents difficulties in the way of return, besides the excitement attendant on the accident, and the risk of wounding of the viscus by the patient's movements. In the small creatures we are unable to carry in the hand, but we have the advantage of holding them up by the heels

while reposing the extruded mass. It is important first to secure the animal in such a way as to prevent her from self-inflicted injuries; to place a disinfected sheet under the extruded mass, and with the warm antiseptic preparation wash it free of foreign matter. With adequate assistance to support the weight, one may replace the organ by gentle but continuous manipulation. Resistance in the way of throes or labour pains may be expected, and it is in the intervals that progress is made. Reposition is generally accomplished with patience, but retention presents an even greater difficulty. A West's clamp is the best instrument, but in its absence stout sutures should be passed through the lips of the vagina, enclosing much of its substance to prevent the stitches from tearing out. Hand pressure over the withers has a certain measure of value in deterring a beast from straining. A large dose of chloral or opium or other sedative or anodyne may be given with advantage, and repeated if labour pains continue. The animal should be made to stand on ground lower in front than behind, fed sparingly on food that is not bulky, and kept perfectly quiet. When the accident has not been witnessed and any serious laceration has taken place, the only hope of saving the animal's life is to ligature the neck of the womb and excise it. [H. L.]

Eversion of Uterus in Mare

V

Vagina, Diseases of.—Vaginal troubles are almost exclusively connected with reproduction. Rupture of the vagina by the male organ sometimes occurs, resulting in death from peritonitis. This happens also in difficult parturitions. Bleeding after copulation in the case of young heifers served by bulls of larger growth is recognized as over-bulling. Constriction and other deformities are rare in all species. Inflammation of the vagina after difficult labour and the employment of mechanical appliances to extract the fœtus entail considerable risk, as it is often septic in origin and leads to parturient fever (which see). An infectious gonorrhœa is communicated by copulation (see Bull, Burnt). Debilitated mares and cows, especially old animals that have frequently bred and not been well cared for or sufficiently fed, are liable to a thick whitish mucous discharge from the vaginal membrane, which is known as the 'whites'. Any abnormal secretion of the mucous membrane is of special importance because inimical to the life of the spermatozoa of the male, and sterility, according to the latest report of the Board of Agriculture, is largely due to a very prevalent infectious vaginitis among cows. *Treatment.*—When trammelled or subdued by anæsthesia, we are able to strangulate polypi and remove in various ways adventitious growths. Ruptured vagina may be sutured and antiseptic appliances employed. Bleeding without actual rupture, as in over-bulling, is not usually attended with permanent bad results; but a simple astringent, as alum in solution, should be used to arrest the hæmorrhage if persistent, and afterwards permanganate of potash injected. Inflammation is allayed by soothing remedies, as glycerine and warm water combined with a little carbolic acid, gently introduced by means of a syringe. Parturient fever is combated with quinine and gentian and mineral acids. (See Medicines, Doses of.) Infectious, or simple vaginal catarrh, is treated by daily injections of weak carbolic acid at first, and later by boracic acid and glycerine, meantime paying strict attention to diet and avoiding all sources of infection. [H. L.]

Vagrant, Vagrancy.—In ancient times

large numbers of Statutes were passed both in England and Scotland dealing with vagrants and vagabonds, most of which have been superseded. Modern law rests principally on the Vagrancy Act of 1824, applicable in its entirety to England, while section 4 is applicable also to Scotland; and as regards Scotland generally, also on the Burgh Police Act of 1892, and the Local Government (Scotland) Act of 1899. In England, persons who refuse to maintain themselves and their families; or who leave a place to which they had been lawfully removed under an order of the justices; and unlicensed pedlars, prostitutes, and beggars, are to be deemed idle and disorderly persons, and may be sentenced to a fine not exceeding £5, or to imprisonment, with or without hard labour, for not more than one month. Both in England and in Scotland, persons wandering abroad and living in barns or outhouses, unoccupied buildings, in the open air, or under a tent, &c., without visible means of subsistence and not giving a good account of themselves, are defined as rogues and vagabonds, and may be sentenced to a fine not exceeding £25, or to imprisonment for a period not exceeding three months. The same sentence applies to persons professing or pretending to tell fortunes, or using palmistry or other device to impose. In England, persons convicted as rogues and vagabonds after previous conviction, persons committed under the Vagrancy Acts and escaping from prison, or persons convicted as rogues and vagabonds who are proved to have violently resisted arrest, may be committed by the justices to prison with hard labour until the Quarter Sessions, and may be sentenced by a Court of Quarter Sessions to further imprisonment not exceeding one year with hard labour, and, if males, also to be whipped [D B]

Valeriana, a large genus of mostly hardy perennial herbs, sub-shrubs, and shrubs (nat ord. Valerianeæ), with white or pink flowers, chiefly natives of the northern temperate regions and South America. Few of them are of horticultural merit. *V. officinalis* (Common Valerian) is common in moist situations in Britain, and is cultivated in the United States. The roots possess powerful antispasmodic and stimulant qualities, and are used in cases of hysteria and allied complaints. Cats are remarkably fond of them. The better-known species include *V Phu* (Greater Valerian), *V. dioica* (Small Marsh Valerian), *V. celtica*, and *V. sitchensis*, a North American species with medicinal properties. The roots of *V. edulis* are eaten by the Indians Corn Salad or Lamb's Lettuce (*Valerianella olitoria*) belongs to this natural order. Red Valerian is *Centranthus ruber.* [W. W.]

Valuation.—This word has a very wide significance, and if it were to be treated in a perfectly full and comprehensive way, would require a whole volume to itself.

A valuer is 'born not bred'. But to a natural aptitude for correct and reliable results, a valuer must add experience in the art of comparison, in perceiving the good and bad points of the matter under appraisement, and in being able to discern the probabilities of improvement or of deterioration.

In this article we propose to exclude the valuation of minerals, and to confine the remarks to agricultural land.

I. In the **valuation of a landed estate,** for sale or purchase, there are many and diverse interests to consider. The ownership of an estate has certain privileges which an owner of, say, Consols has not. He must therefore be content with a smaller return on his capital outlay than one who invests his capital in some commercial undertaking. Unfortunately there is not the confidence in the stability of income from land that formerly existed, when the rate of interest derivable from investment in land was generally calculated to exceed slightly the income produced from investment in Consols.

If the rent paid by the occupier was formerly a fair index of the returns which might reasonably be expected, it is so no longer, and many cases are known where the rents were kept at an inflated value, merely to secure a good sale of the property All the time, abatements may have been given to the occupiers, which did not appear in the rent-rolls. This only serves to show the absolute necessity for making an accurate and systematic valuation of an estate, and not trusting to mere 'book rents'.

After arriving at what may be considered a fair and equitable rent-roll, viz rents on which the present tenants would be willing to renew their leases, what other considerations have to be taken into account?

Besides the actual rental now being received, a probable purchaser would have to consider the following points —

1 *Feuing Value.*—Is there any prospective feuing value? and if so, for how many years will it be deferred, or how long will 'development' take? What expenditure will be required in order to develop the estate before any return can be obtained? To arrive at these values, one would have further to consider the present travelling facilities, the possible extensions of these, the demand for workmen's houses in the district, the educational facilities, and many other local considerations.

2. *Sporting Rights* —It may be that no rental is being obtained for sporting rights, and this value will have to be taken into account in appraising the total value of an estate. The sporting rights are now valuable, especially if grouse moors, deer forests, and salmon fishings are included singly or together.

3. *Woods.*—If the woods on the estate have been carefully attended to and planted on a systematic plan, it may be that these will yield a yearly sum for wood cut down and sold. As a deduction from this yearly sum, there must be placed a charge for renewing the plantations and general upkeep.

There are besides some general considerations to take into account before finally settling the yearly rental that may be counted on, such as—

(*a*) Have rent abatements been general or exceptional? Are they temporary or permanent?

(*b*) Have the rents been paid regularly? or if they are in arrears, what is the reason?

(*c*) Have the tenants been long resident on the estate, or are they of a 'migratory' nature?

(*d*) Is the estate well supplied with farm cottages for the labourers?

(*e*) Is the estate conveniently situated for markets, railway stations, schools, churches, post offices, &c.?

(*f*) Is the estate well intersected with main or county roads, and are these convenient for the working of the various farms?

(*g*) Are the farms well provided with shelter for stock, and have they a cold and northerly or warm and southerly aspect?

(*h*) Are there any acknowledged or alleged rights of way, by which stock may be constantly disturbed and crops destroyed?

There may be other local considerations before we can finally determine what is a fair yearly rental to be derived from the property, which we call the *gross rental*

We now come to the expenditure side of the question, and we will have to consider the following points:—

A. Annual Expenditure

1 *Rates and Taxes.*—(*a*) All local rates and taxes have to be deducted from the gross rental, such as Poor, School, Registration, Cemetery or Burial Ground, and special Parish Rates.

(*b*) The County rates have to be carefully examined to discover whether, besides the usual rates, any part, or the whole, of the estate is included in 'special districts', for water, sewage, scavenging, lighting, &c

(*c*) The Land Tax may either be payable yearly or it may have been commuted

(*d*) There are also what we may call extra-parochial burdens, such as stipends to parish ministers, and the average annual expenditure that may be expected to be necessary for the upkeep of the parish churches and manses on the estate The churchyard may also have to be enlarged in the near future at the expense of the heritors.

Besides the present stipend payable to the parish minister, the value of the teinds would have to be known, to discover whether they were exhausted, or to what extent they would allow an augmentation of the stipend. If they are not exhausted, one may count on the parish minister asking for an augmentation after a lapse of about twenty-one years from the date of the last augmentation.

Besides all these local rates and taxes, we should consider also:—

2 *The insurance premiums*, payable on the various buildings on the estate. The policies would have to be examined to discover if the amounts insured are fair and reasonable. The leases would also have to be seen, to show whether the tenants pay any part of the insurance premiums.

3. *Annual feu duties* may be payable by the estate.

The preceding amounts may be considered to be annual and regular expenditure, which may quite safely be admitted to be capable of yearly increment.

B. Capital Expenditure

Besides the annual expenditure, we have to consider what expenditure is required to put the estate into a condition in which reliable and worthy tenants will be induced to offer reasonable rents without any demand from them for abatements.

1. *Drainage.* — Every farm and every field must be examined to know what expenditure will be incurred for drainage and at what cost.

The price of labour in forming drains will depend on: (1) the nature of the soil and subsoil, (2) the general configuration of the ground, according to which it may be necessary or not to cut very deep main drains, (3) the presence or absence of good drainers in the district, and (4) the distance of the farm from the nearest tile work.

The leases would also have to be examined to discover whether the tenants are to pay interest or not on the total cost, to be borne by the owner, or whether they have to do all the labour on receiving the tiles free from the proprietor.

2. *Farm Buildings* – The buildings on each farm require to be carefully examined. A probable purchaser would have to satisfy himself as to what sum will be required to put the buildings of each farm into a proper condition to meet modern requirements. He should also calculate the present value of that cost, should he find that the alterations or additions are not required for, say, a period of five or ten years.

The times for making the various expenditures must be taken into account, because if it were found that one half of the leases fell out within twelve months and all these farms required a large expenditure at once, a much larger sum should be allowed than if these leases expired only over a series of five or ten years. The present value of a deferred sum for expenditure is much less than that sum if it had to be spent within the next two years.

3. The same remarks may be taken to apply to *fences, roads, water supplies, &c.*

4. *Meliorations.* — Although now almost extinct, 'meliorations' have to be taken into account on some estates—that is, the buildings, or parts of the buildings, belong to the tenants and have to be paid for by the proprietor at the end of the current leases.

5. *Mansion House, &c.*—The condition of the mansion house, of stables, of garden houses (including dwelling houses for gardeners and also glasshouses, bothies, &c.), of lodges, of policies, of woods, of home farm (if not already included under farms), will have to be considered, and an estimate made of the yearly expenditure required on each, as well as any capital expenditure that may be necessary.

6. *House Property.*—If the estate contains much house property besides the usual lodges and estate labourers' cottages, a purchaser would have to know the class of tenants at present in occupation, the condition of the buildings, and the probable yearly and capital expenditure.

There may be other local or peculiar features to consider, such as any prospective value the

estate may have for waterworks for a large town or district, or for railway development.

Having arrived at the fair *gross* rental of the estate, we will first of all deduct the usual burdens, viz. 1 (*a*) local rates and taxes, (*b*) county rates, (*c*) land tax, (*d*) stipend and other extra-parochial charges, along with 2, *fire insurance premiums*, and 3, the *annual feu duties* payable by the estate.

We also add to the above deductions a sum for the usual yearly repairs, equal to say 5 per cent on the rental of the estate, excluding, however, the rents of shootings and fishings; and also a sum for management, of say 5 per cent on the gross rental, including that of mansion house if it is to be let.

This will give the *net* rental of the estate. To arrive at the *capital value* we multiply this net rental by the appropriate number of years' purchase. What that may be, it is impossible to state in a general article of this nature.

But if we were to allow a 4-per-cent basis, or twenty-five years' purchase, we would be entitled to deduct from the capital value so arrived at, a sum to represent the capital expenditure (apart from the usual annual upkeep) that would be required to put the estate into a good state of repair, viz. (1) drainage, (2) farm buildings, (3) fences, roads, &c., (4) mansion house, and (5) house property.

The 4-per-cent basis, or twenty-five years' purchase, would apply only to a general agricultural estate on which there was little house property (except for estate and farm labourers), and where there was not much feuing land.

In such cases the rents of these houses are taken at a nominal sum, while the shootings which are not to be let are also put in at a nominal rent. These, therefore, may be taken as part of the agricultural estate.

But on the other hand, if there is a considerable amount of house property let to outside tenants, these houses would be worth from twelve to twenty years' purchase according to their conditions.

If the shootings are let at a fairly good rent, that rent may be put at fifteen years' purchase.

In the case of feu duties, much will depend on how they are secured and the amounts of feu duty. If the security is good and the amounts exceed £5, it may be possible to obtain twenty-five years' purchase; if under £5 in amount, twenty-two or twenty-three years' purchase; and if below £1, twenty years' purchase.

II. In the **valuation of a farm**, with a view of offering a yearly rent under a lease or agreement, a prospective tenant would consider many of the above considerations.

1. He would also carefully peruse the estate conditions of let, shown to him, to discover what are to be his liabilities to the proprietor in the matter of (*a*) insurance premiums; (*b*) erection of new buildings, fences, &c.; (*c*) upkeep and repair of buildings, fences, drains, roads, &c.

2. He will next thoroughly examine the whole farm, field by field, and satisfy himself as to the following: (*a*) Condition of buildings, fences, drains, &c.; (*b*) condition of the land as to productiveness; (*c*) whether each field is well watered and sheltered; (*d*) whether each field has good roads for access and is properly laid off for cropping purposes; (*e*) whether the land will yield late or early crops, what crops are possible, and the average yield of each per acre; (*f*) whether the proprietor keeps a large or a small stock of game and rabbits, and the probable amount of damage thereby; (*g*) the location of markets and railway facilities; (*h*) whether there is a limited or ample water supply, and whether it is by gravitation or otherwise.

On the foregoing data and any other local conditions the rent has to be calculated. The ratio of rent to produce and expenses is, however, a very variable quantity. It differs with the quality of the soil, the kind of farm, whether it is arable or pasture, with the system of farming, with the methods and appliances used in working, with the capital of agriculture, with the current prices of produce, labour, and manure, and with the situation, aspect, and exposure of the farm as a whole [C W. S.]

Valuation of Foodstuffs. See Feedingstuffs, Valuation of.

Valuation of Manures. See Manures, Valuation of.

Vapourer Moth, a brownish-coloured moth, the larvæ of which destroy the foliage of fruit trees, especially the plum. See art. Orgyia.

Variation.—The members of a family, of a herd, or of a species are not usually all alike, nor are those of one generation the exact counterparts of those of another. In almost all the cases that have been carefully studied there are peculiarities distinguishing the various individuals, they agree in essential features, they differ in minor details Those individual peculiarities that are inborn are called variations, and they must be distinguished from individual modifications which are acquired as the direct result of something unusual in the food or surroundings, or in the habits and conditions of life generally. These modifications or acquired characters are due to peculiarities of *nurture*; whereas variations emerge from within and are expressions of peculiarities in the hereditary *nature*. Many kinds of variations are hereditarily transmissible, but we do not know of any clear case in which a modification acquired by a parent is transmitted as such or in any degree to the offspring. Thus it is that variations form the raw materials of evolution. In his famous work, The Variation of Animals and Plants under Domestication, Darwin accumulated a large body of evidence showing the variability of living creatures kept under human control, and we now know that this does not exceed what is exhibited by animals and plants in natural conditions. In both cases there seems to be a continual opposition between the persistence of hereditary resemblance on the one hand, and the appearance of novelties on the other. We are apt to exaggerate the amount of variability in domestication, as in pigeons and poultry for instance, because man artificially preserves so many new departures. They are not less frequent in wild nature, but they are more severely pruned.

Some of the results of the modern study of variation may be briefly stated. (1) There is a proportion between the frequency of a particular variation and the amount of its departure from the average of the character in question. (2) One variation is often bound up with another, bringing it in its train. As Darwin said, there is a 'correlation of variations'. The living creature sometimes changes as a whole, not in this corner or in that, but through and through, and all at once. (3) Through the work of Bateson, De Vries, and others, there has accumulated a body of evidence showing that changes of considerable amount sometimes occur at a single leap. 'Discontinuous variations' of certain kinds are not uncommon; that is to say, new departures in structure may appear suddenly in a litter or clutch or seed-plot, and may show from their first beginning no small measure of perfection. There is evidence in a few cases that a breed may arise not by the slow increase of minute fluctuations, but by getting a big start in a discontinuous variation.

As to the *origin* of variations, we must still confess with Darwin 'Our ignorance of the laws of variation is profound. Not in one case out of a hundred can we pretend to assign any reason why this or that part has varied' Yet some progress has been made There are variations that mean nothing more than an augmentation or diminution of an already existing character The hair of the horse's mane may be very long or the tail of the cat may be very short Or a variation often means that a character present in parents or ancestry is absent from the offspring the entail has been broken An albino expresses such a variation, or a hornless calf in a horned race, or a tailless kitten in a race with normal tails. Or, again, a variation may be interpretable as a novel arrangement of characters or qualities which were present in the ancestry A piebald pony illustrates this. Now, in regard to variations of this sort—permutations and combinations of already existing characters we know that there are many opportunities for rearrangements of the microscopic bearers of the hereditary qualities in the extraordinarily intricate changes that go on in the germ cells (ovum and spermatozoon) before and during fertilization. As to those variations which are qualitative rather than quantitative, in kind rather than in degree, we can only speculate It may be that the stimulus to germinal variation comes from the changes that are always occurring in the blood and the other fluids which supply the germ cells with food; it may be that there is within the germ cell some sort of struggle between rival ancestral items that make up the hereditary equipment; it may be that important changes in the environment may saturate deeply through the body and stimulate the germ cells to vary. Thus although environmentally produced modifications do not seem to be transmissible, environmentally induced variations may turn out to be part of the raw materials of evolution. In the meantime it is incumbent on every breeder and cultivator to record and measure variations and to state the conditions of their occurrence. [J. A. T.]

Varicose Veins. — Permanently dilated veins with their walls thickened, more particularly at the valves, occur in horses' legs, and along the milk vein of cows, and in other places, but are seldom of importance or calling for surgical interference. Where bandages can be applied, reduction follows on judicious pressure.

[H. L.]

Variola. See Pustulation.

Veal Production. - Veal, the flesh of the young fat calf, is produced more especially in the neighbourhood of large towns, and is found to a much larger extent in England than in Scotland The conditions which determine the profitable production of veal are cheap calves, surplus milk, and a good market. With these conditions fulfilled, vealing can proceed either by allowing the calves to suck their dams or by hand-feeding.

The finest veal is produced by the first method The suckled calf requires very little attention, and on this account this system is often adopted. At first the newly-born calf is unable to take all its mother's milk; the surplus may be removed either by hand or by allowing another bigger calf, which is getting an insufficient supply for rapid fattening, to clean the udder out once or twice a day With deep milkers it may be necessary to give each cow a couple of calves from the beginning. These would have sufficient for the first two or three weeks, when it might be necessary to remove one or allow it periodically to suck another cow in order to keep them both fattening rapidly. This system is not so suitable for cows which are kept for dairy purposes, as it unsettles them, and unless the cows are carefully stripped each day the annual yield of milk will be considerably diminished

The system of hand-feeding is specially suited to dairy farms in spring, as there is often a surplus of milk available at this time According to Dr Gillespie, 'Hand-feeding requires skill, and above all, careful management and unremitting personal superintendence. The person in charge must be thoroughly reliable and very painstaking, and the food must be given with scrupulous care and regularity.' For success in hand-feeding the following points should receive careful consideration.

The Calf Box.—Previous to the introduction of the calf, the box should be thoroughly cleaned out, the floor disinfected, and the walls limewashed. Efficient ventilation and adequate lighting arrangements are also requisites for success. With these conditions fulfilled, the calf may be safely introduced on to a comfortable bed of clean straw. Quietness is essential for rapid fattening, and unless each calf has a separate box they should be tied up by the neck sufficiently short to prevent them reaching their neighbours.

Food.—For the production of a whitish-coloured flesh no more suitable food has been found than milk; but it is expensive, especially where there is a demand for it for human consumption. A raw egg is sometimes switched in the milk. More frequently cream substitutes, such as linseed jelly, ground linseed cake made into a gruel, or cod-liver oil, are employed, but most of these are apt to darken the colour or otherwise

diminish the value of the veal. The old practice of frequently bleeding the calves to whiten the flesh is now discontinued, and the lump of chalk which is often placed in the manger is used rather for the purpose of correcting acidity in the calf's stomach than for whitening the flesh. After the calf gets two or three months old the flesh gradually loses in colour, and it is not advisable to keep calves longer than this for veal; in fact, seeing that the best veal is produced by milk, and that milk is an expensive food, it is imperative to veal calves as rapidly as possible.

Great care has to be exercised in the hand-feeding of calves during the first few days of their lives. The milk should always be given warm and fresh from the cow; and as the calf will often drink more than is good for it during the few days, the quantity should be carefully restricted. During the first day a pint each time, three times a day, is quite sufficient, and with an average Shorthorn calf of about 88 lb. live weight at birth, 1½ gal. of milk by the end of the first week, 2 gal by end of the second, 2½ gal by end of the third, and 3 gal by end of the fourth, is as much as the calf can economically use.

The writer has found it a distinct advantage to add to the sweet milk a little buttermilk—a small quantity at first, and increasing it to about 1 part of buttermilk to 10 parts of sweet milk. This may be commenced when the calves are a fortnight old, and has the effect of sharpening their appetites. The buttermilk has no injurious effect on the quality of the veal, and calves fed on milk with a little buttermilk added often scale heavier weights than one would anticipate from their size.

Frequent feeding at regular intervals is a decided advantage. Average Shorthorn calves fed three times a day may be made 11 st. live weight and ready for the butcher by the time they are a month old, while calves fed twice a day will take an extra week, and even then they will scarcely be as heavy as those fed three times a day. By feeding three times a day about 9½ lb milk give 1 lb of increase, while with feeding twice a day it will take 10½ to 11 lb of milk to give the same result.

Probably four to five weeks is as long as it is advisable to hand-feed calves intended for veal on a dairy farm, or until they have reached 160 lb. live weight or 96 lb. veal. An effort should also be made to have the calves fat at the time veal commands a high price, or the returns for vealing will not be great. It must usually be regarded as a convenient way of utilizing surplus milk. [J Po.]

Vegetable Garden. See art. Kitchen Garden.

Vegetable Marrow. — When used as a vegetable the fruits of this most popular plant (*Cucurbita Pepo* var. *ovifera*) should be cut when half grown, or even earlier, thus facilitating the production of others. At this stage the flesh is pleasantly tender, but later in the season a few fruits may be allowed to develop for jam-making, or to be kept for autumn use. Seeds should be sown towards the end of April in small pots placed in gentle heat. After a hardening-off process the young plants are put out at the commencement of June, being protected for a few days by hand-lights, or such substitutes as large flower-pots or market baskets. It is common to plant marrows on old manure heaps, in which position they do very well, but any well-manured soil is quite suitable, and to plant them on small hillocks here and there among the early potato crops is a good plan. Market growers plant marrows in trenches 4 ft. wide containing half-decayed manure with soil on the top, and water them till well established. The growths may be occasionally thinned with advantage, and it is as well to afford some protection from early frosts. Marrows look very well when grown over arbours and fences, as are the more purely ornamental gourds. Where an extra early supply is desired, they may be greatly forced on hotbeds in frames; when this is done the flowers require fertilizing. Bush Marrow, Long White, Vegetable Cream, and Pen-y-byd are favourite kinds. [W. W.]

Vegetables.—The term 'vegetable' is properly applicable to any plant, but in a horticultural sense it indicates only such plants as are cultivated for some edible part, and sometimes—as in the case of the tomato—that part is the fruit. Vegetables provide us with a great variety of excellent and very wholesome food, and dietetists generally are agreed that it would be better if they were even more extensively used. Only a few centuries ago the choice of vegetables was very limited. Their quality has also immensely improved during the last hundred years, and it continues to advance, but in this country particularly there are a number of good vegetables, such as cardoons, celeriac, Indian corn, salsafy, scorzonera, sugar peas, and a number of salad plants, which are but little favoured. But the choicest vegetables are of little value if unskilfully served; and in this particular it must be admitted that the reputation of English cooks is not high, nor are they very willing to mend their ways. The possession of a well-managed kitchen garden is of inestimable value to a household. Those who have to purchase their supply suffer somewhat from the usual system adopted by the growers of sending vegetables to the large markets; whereas could local produce be secured directly, it would be fresher, cheaper, and more satisfactory in every way. There is a tendency to esteem size before quality in vegetables, and they are too often grown mixed up with fruit trees and bushes and other crops, whereas it would be better to keep them apart. Their nomenclature is very confused, many of the seedsmen having given names of their own to what are identical varieties. It is a real economy to purchase seeds of the best strains from reliable firms. It is a good thing that more attention is now being devoted to the raising of extra-early vegetables with the aid of hotbeds, cloches, &c. It is to be regretted that our imports of fruit and vegetables are so large. [W. W.]

Venison.—The name of venison is now confined to the flesh of animals of the deer tribe, used for food; but it had formerly a more extended meaning, being applied to almost any

objects of the chase, of which the chief were deer and boar. In England, the only venison usually consumed is that which comes from the stag (or red deer) and from the fallow deer, called respectively red venison and fallow venison. At high-class tables the haunch only is served, consisting of one leg with half the saddle attached. The neck, however, may also be roasted. The flesh of the roedeer is of poor quality, and so little eaten in England, that when required for any special function it often has to be imported from the Continent. When used, the joints taken are the leg and the saddle. In old times venison was a far commoner article of diet than it is at present. The New Forest was only one of many deer forests in England, where large numbers of fallow deer were protected from the inroads of the plough and of other pasturing animals. They are now preserved only in a few gentlemen's parks, while deer stalking is confined to the Highlands, where the red deer still exists in a wild state

[H. S. R. E.]

Ventilation.—The proper ventilation of farm buildings is one of great difficulty. In this article we shall deal, not with the ventilation of the farm dwelling-house, but chiefly with that of the cow byre, since the Local Government Board insist on certain regulations for such a byre before it can be used in connection with a dairy. Similar ventilation, although in a modified degree, should be provided for other byres, stables, &c.

Ventilation is very often considered to be merely a matter of sufficient air space in a byre. But a byre with a comparatively small air space is, if properly ventilated, much more healthy than a byre with a very large air space and badly ventilated. To secure thorough ventilation the air must be kept continually moving, in order to expel the foul air and induce a current of fresh air from the outside. Unless this is done, a byre with a large air space and deficient ventilation is subject to extremes of temperature. It is too cold when the cows return to it from the outside, and after it is occupied by cattle for some time it becomes too warm. The foul air has not been allowed to escape, and no fresh air has been admitted.

County Councils are now empowered to make by-laws to regulate the construction of dairy byres and other premises. These by-laws are subject to the approval of the Local Government Board. This Board invited the attention of Local Authorities to the following recommendations of the Royal Commission on Tuberculosis:

1. 'A minimum cubic contents in cow sheds in populous places of from 600 to 800 ft. for each adult beast, varying according to the average weight of the animals.'

2. 'A minimum floor space of 50 ft. to each adult beast.'

3. While prescribing the above two recommendations, the Commission added that 'they were distinctly of opinion that the dimensions affecting ventilation and lighting are by far the most important, and that requirements as to cubic and floor space are mainly of value as tending to facilitate adequate movement of air'.

4. 'The same conditions as those recommended for populous places should apply to cow sheds in sparsely populated places, except in so far as cubic contents per cow are concerned; as regards these cubic contents, such space per cow should be provided as would, in view of the surrounding circumstances, secure reasonable ventilation without draught. But the physical circumstances prevailing in different localities being so various, we do not find it practicable to prescribe uniform minimum requirements in this respect.'

Everyone will admit that these recommendations are eminently sound and sensible. In the first one, it is to be noted that the cubic contents prescribed are for *adult* beasts and not for young cattle, as is so often asked by Local Authorities. The Commission also drew a distinction between animals of different weight, as, for instance, an Ayrshire cow does not require the same cubic contents as a large Shorthorn cow. They also made it clear that an absolutely uniform minimum cannot be obtained all over the country. The physical circumstances of each case must regulate to a large extent the requirements of the Local Authority. A byre in an exposed wind-swept situation at an altitude of, say, 600 ft. above sea level would have to be differently treated from a byre situated in a burgh or other populous place, at an elevation of perhaps only 50 ft. above sea level.

The Local Government Board added the following. 'The distinction as to 'cubic contents' per cow in 'populous' and in 'sparsely populated' places recommended by the Commission rests ultimately upon the influence of these local conditions upon the regimen of the cow. If cows are habitually grazed on grassland during the greater part of the year, and when not so grazed are habitually turned out during a portion of each day, then there is a reasonable ground for some distinction in the regulation of 'cubic contents' as between such cows and cows kept and fed under cover during the whole or greater part of the year and not turned out during a portion of each day.

'Although in general the regimen which justifies the prescription of the lesser cubic space per cow exists in counties, and the regimen which demands the greater cubic space exists in burghs, the Board recommend all Local Authorities to base any distinction which may be made upon the fact whether cows are or are not 'habitually grazed on grassland during the greater part of the year, and when not so grazed are habitually turned out during a portion of each day'. The Board recommends a minimum floor space of 50 ft. in all cases.'

But the Local Government Board, in framing their 'Model Regulations' for dairies, cow sheds, and milk shops, go considerably beyond their own recommendations. These 'Model Regulations' require 600 cub. ft. per cow for cows 'habitually grazed', &c., and 800 cub. ft. for cows not so grazed. This is far too high. A lower minimum should have been recommended, so

that Local Authorities could deal with each case as it arose, and dispose of it on its merits.

Local Authorities in Scottish counties show great variations in their by-laws. The cubic contents range from 300 to 800 ft. per cow for old byres, and from 400 to 800 ft. for new byres.

One county is content with 300 cub. ft. in old or existing byres, and requires 400 cub. ft. in new byres.

Two counties require 350 cub. ft. for old, and 500 cub. ft. for new byres.

One district in one county requires 380 and 500 cub. ft. respectively.

Three counties and ten districts in other four counties require 400 cub. ft. in old byres, but in new byres their demands range from 500 to 800 cub. ft.

One district in one county wishes 420 cub. ft. in old, and 800 cub. ft. in new byres.

Three districts in two counties ask for 450 and 600 cub. ft. respectively for new and old byres, while one of these counties allows 400 cub. ft for all byres on exposed sites.

Nineteen districts in eight counties wish 500 cub. ft for old byres, and 600, 650, or 700 cub. ft. for new byres.

One county wishes the same, viz. 500 cub. ft for old, and 600 cub. ft for new, for cows 'habitually grazed', &c.

For cows not so grazed, this county requires 600 cub. ft. for old byres as well as for new byres

Two districts in two counties ask 600 cub ft for both old and new byres.

One district asks 700 cub. ft. for old byres, while another district in the same county requests 800 cub. ft for both old and new byres

It is seen from the above that only one county in Scotland has adopted the recommendation of the Local Government Board as to cows being 'habitually grazed or not'.

If we take the floor space per cow, we find that only five districts in four counties make any stipulations at all One asks 35 sq ft for old, and 42 sq. ft for new byres, three require 50 sq ft, and the other stipulates for 'not less than 14 ft. of breadth in byres'.

Then as to cows being 'habitually grazed or not', besides one county above mentioned, only one other county seems to have considered this matter at all, and asks 400 cub. ft. for cows 'habitually grazed', and 600 cub. ft for cows not so grazed.

If we consider the regulations for 'lighting', only two counties make any requirement as to this in their by-laws. One of the two counties last mentioned as having considered the 'grazing' question, has also considered the lighting problem, and asks for 3 sq. ft. for every two cows. Another county requires for all byres erected after May, 1896, 1 sq. foot of glass for every 600 cub. ft. of air space, and at least 6 sq. ft. in each byre.

As regards ventilators only one county makes any stipulation—the same county that had considered the 'grazing' and the 'lighting' problems. That stipulation is that the openings for both inlet and outlet should be at least 30 sq. in. for every two cows, and not above 8 ft. above the floor level. This county also requires all openings to be provided with suitable means of regulating the supply of air, and every person in charge must use this means so as to keep the air in a wholesome condition.

It is therefore evident that no unanimity exists—and none is possible—amongst Local Authorities in Scotland as to the proper ventilation of byres. What is necessary is that Local Authorities should not make any hard-and-fast rule as to the ventilation of every byre in a large and wide district where the conditions vary so much. They should be willing to make a very low 'minimum', if a minimum is required, and then to treat each case on its merits.

How can efficient ventilation be obtained? In theory, all inlets and outlets ought to be capable of regulation. They ought to be capable of being opened and being shut as and when required Conditions of weather change so rapidly, and the temperature of the outside air rises and falls so quickly, that some sort of regulation seems to be essential if byres, &c, are to be kept at an equable temperature

Inlets and outlets can be controlled, but the chief difficulty is to have a person present to control them at the right time. If the control could be made automatic all would be well, but probably this is impossible Several control ventilators are now on the market (see VENTILATORS). But until it is possible to find farmers and servants who can and will attend to the opening and shutting of these ventilators just when required, it may be at once admitted that those ventilators that are always open and cannot be closed are to be preferred in every way to ventilators that are shut when they should be open and are open when they should be shut

If the ventilators are properly constructed, that is, if they are made and fixed in position so that no draughts are caused to the animals in the byre, &c, it is better to have them always open and never shut, than to have them sometimes open and sometimes shut Avoid all draughts and we cannot have too much ventilation; but we may have too little [C W S]

Ventilators.—An automatic self-adjusting ventilator that will always act in all sorts of weather has not yet been discovered. Such a ventilator is very much needed for farm buildings. There are two classes of ventilator, one for admitting fresh air and the other for expelling foul air

1. As to the former, the common form is an opening in the walls of the building. For granaries, sheds, and such buildings the opening may be near the top of the wall or near the floor level; for stables they are generally placed near the top of the wall; for byres they are placed either near the floor level or at a height just clear of the heads of the cows. In theory they should be placed at the floor level. Cold fresh air being heavier than heated foul air, should be taken in at the lowest level so as to cause a continuous flow of air from floor to ceiling. If taken in at a higher level, the cold air must first fall down towards the floor

and again rise when heated, and this may cause draughts on the backs of the cows. Most farmers, however, prefer the inlet about 5 ft. above the floor level.

The simplest form of fresh-air inlet is a fireclay pipe inserted in the wall. If of 4 in. diam. it should have an upward slope to the inside of not less than 4 in.—that is, a slope not less than its internal diameter. It should be cut to that angle so that no sharp corners project on the outside or the inside wall. The pipes might be made as fig. 1, of glazed fireclay. Another form is seen in fig. 2. This is made by the Gartcraig Fireclay Co. Ltd, 18 Charles Street, St. Rollox, Glasgow, and is made for a 9-in. brick wall. They have an air space of 31½ sq. in. They are glazed with pottery glaze inside and vitrified outside. The ventilator, including the grating, is made of the best fire-clay. The inside mouth is contracted to cause the fresh air to be forced into the centre of the byre. The contraction, however, is apt to choke the free passage of air. The other disadvantage of this inlet ventilator is that the mouth projects into the byre beyond the face of the wall, and will thus collect dust, &c. Inlets of this kind are also not easily controlled when made in this shape. On the other hand, the projection tends to throw the air more upward.

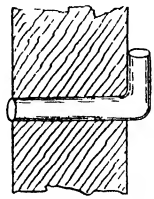


Fig 1

Fresh-air inlets should be placed in the centre of each stall, one for every two cows. They should be constructed in such a way that they can be regulated as required. This can be done

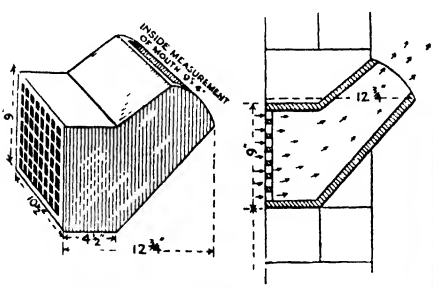


Fig. 2

so that all the inlets can be opened at one time, or some may be opened and others closed. It is necessary at times to have the ventilator of one stall for a newly calved cow entirely closed. The system introduced and patented by Mr. John Barr, Sanitary Inspector for Stirlingshire, is probably the best and most effective.

They may be made singly or in groups of two, three, four, five, or any number required. Fig. 3 shows a single valve, while a group of three valves is shown in fig. 15. They are opened by the pulling movement of a wire with chain pull attached, which is then slipped on to a pin in the wall, when the valves are to be open. When they are to be closed the chain is released from the pin, and the valves swing down by their own weight. They are adjustable, and may be closed, partially closed, or fully open, as desired. They are made in three sizes, to give inlets of 4 in., 6 in., and 9 in. in diameter. The 6-in. and 9-in. valves may be had in glass, to admit light when closed. If it is desired to have one valve closed and all the others open, the valve to be closed has its lever disconnected from the link into the wire.

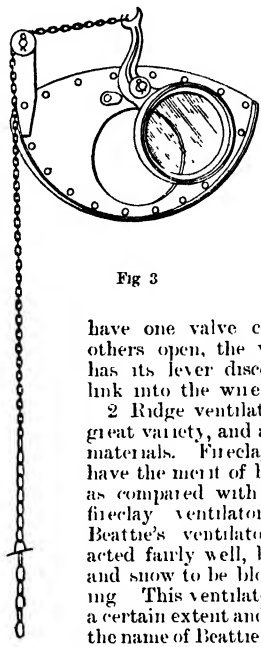


Fig 3

2 Ridge ventilators may be had in great variety, and are made of various materials. Fireclay ridge ventilators have the merit of being indestructible as compared with wooden ones. Of fireclay ventilators the first was Beattie's ventilator (fig. 4), which acted fairly well, but it allowed rain and snow to be blown into the building. This ventilator was improved to a certain extent and brought out under the name of Beattie's Ventilator (Christie's Improvement) (fig. 5). The opening being less, snow and rain were not so easily blown inside, but more ventilators were required than of the first pattern. The latest form of this ventilator is called 'The Swift', and has been patented by Mr. J. A. Beattie, C.E., Aberdeen. This pattern (fig. 6) prevents snow and rain from falling into the byre, being run to the outside. The openings are not very large, and consequently a large number of these ventilators are required on a ridge. The ridge in fact may be entirely covered by these ventilators placed alternately, or it may be half covered with them, a ventilator alternating with a plain fireclay ridge. All these ventilators are manufactured by Messrs. J. & R. Howie, Ltd., Hurlford, Kilmarnock.

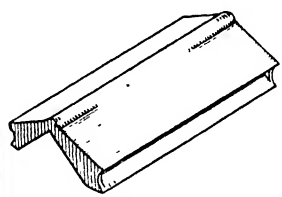


Fig 4

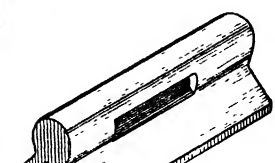


Fig. 5

The Gartcraig Fireclay Co. Ltd. also make a

very good fireclay ridge ventilator (figs. 7 and 8). The air space of the central opening (marked c in the section) is over 20 sq. in. This firm recommends that the ventilating tiles be laid along the entire ridge of the roof. If this is done, there will be nearly three ventilators for each pair of cows, and therefore about 30 sq. in. of outlet ventilation per animal. Galvanized-wire gratings at the entrance of the projecting arms are provided to prevent obstructions from birds' nests, &c. The ventilator is made of fireclay, thoroughly vitrified outside and inside.

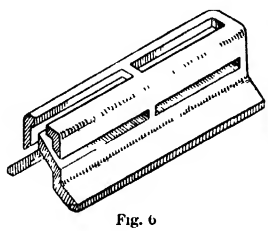


Fig. 6

The double-horn ventilator (fig. 9) is made of zinc, and was at one time very much used. Rain and snow cannot find an entrance, but

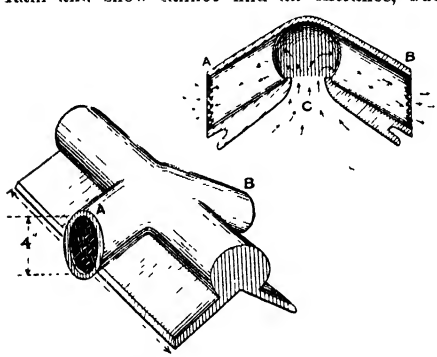


Fig. 7

that is almost the only advantage, as they do not act well. If fitted with a diaphragm or division, as indicated by a dotted line on sketch, they work a little better, as they are not so apt to be choked by a strong wind blowing on one side and causing down-draught without exhausting any foul air.

The louvre ventilator (fig. 10) is also a very common form, but being generally made of wood it is apt to decay quickly, being out of the reach of the paint brush and subjected to the weather outside and damp foul air inside. In other ways it is a fairly satisfactory ventilator.

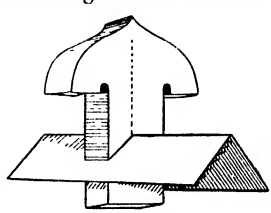


Fig. 9

Another common form of ventilator is that of the slit in the roof, above which is raised a small roof slated over in the usual way. Snow is apt to be blown into this opening; sparrows build their nests in it; and very often farmers close it up with straw in very cold weather and forget to open it again.

One of the best raised-ridge ventilators is

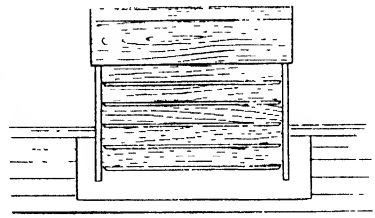


Fig. 10

that made by Mr. Craig, Langbank, Port-Glasgow, and shown in figs. 11 and 12. It is made either of iron or of wood covered with zinc, and has therefore all the advantages and none of the disadvantages of the louvre ventilator. The top of the ventilator is quite open, except that it is covered with wire netting to exclude birds, &c. The top has also a division or diaphragm, and below, and wider than, the shaft is a tray sloped to both ends to run off any water that falls down. A similar ventilator (figs. 13 and 14) is that made and patented by Mr. Taylor, Nether Leask, Ellon, Aberdeenshire. Fig. 14 is controllable from the inside.

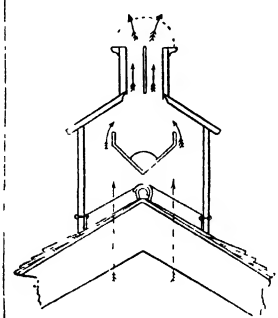


Fig. 11

A system of ventilation has been introduced

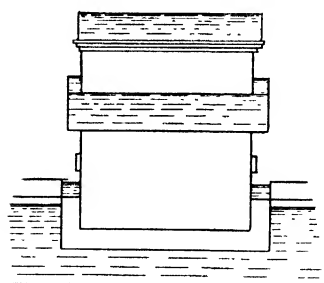


Fig. 12

by Mr. John Findlay, Springhill, Baillieston. He places air inlets in the side walls, about 5 ft. 6 in. above floor level, each 30 sq. in. for each cow or 60 sq. in. for each pair of cows. These inlets are regulated by a lever. At the

ridge the boarding and slates are stopped about 10 in. from the apex of the roof, and this part is then covered with glazed sashes, hinged at the lower edge, which, when closed, meet at the apex. The sashes are connected to a lever, so that they may be opened entirely or partially. This ridge ventilator also gives sufficient light to the byre without rooflights.

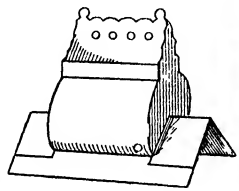


Fig 13

A more recent system of ridge ventilating is that patented by Mr. John Barr, Sanitary Inspector, Stirling. Fig. 15 shows both inlets and outlets. The inlets shown are three in number, the two outside ones having glass panels, the centre an iron panel. The latter is shown disengaged, and therefore closed. The sketch is very illustrative of the ridge ventilation. There are two ridge boards kept apart by blocks to the required width. The ridge boards and all other parts exposed to the weather are first covered with zinc. So are the blocks before being put in, and then are soldered to the zinc of ridge boards. The top may be covered with wire netting to exclude birds, &c. Below the ridge opening is a tray or trough, hung from the ridge boards, and this may be made in two sections for a long roof. As this gutter is swung to ends when closed, it must be a little shorter than the full length of roof. A small part therefore of the ridge at each end must be closed over to prevent rain falling down when the gutter is swung open. If the gutter is in two sections, a small part of the ridge must also be closed in the centre for the same reason. The gutter is a little deeper at one end in order to run the water into a large rain-collecting box. If neatly made this gutter, when swung close by the wire rope and pulley, &c., will entirely close the ridge. Permission may be had at the rate of 1*s.* 6*d.* per

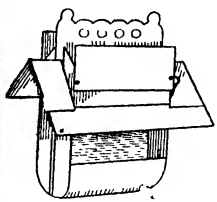


Fig 14

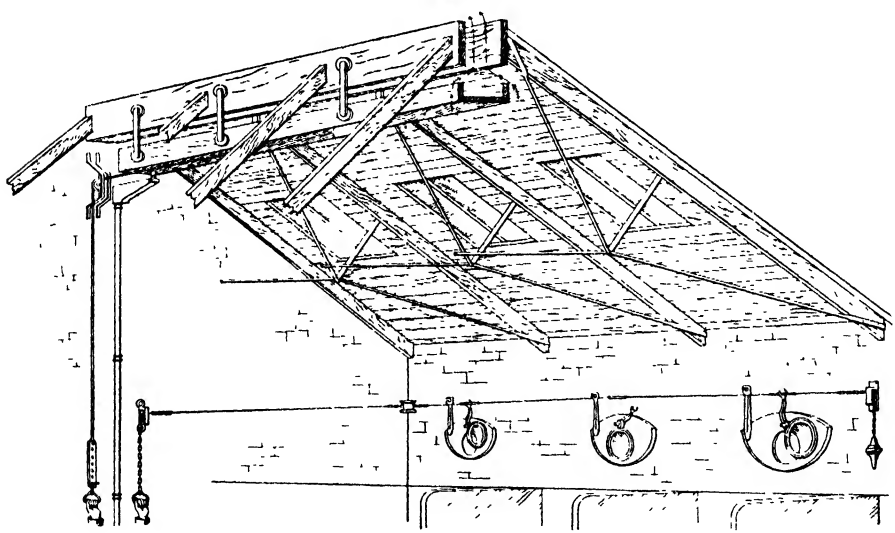


Fig. 15

lineal foot of ridge by any party wishing to construct the ventilator. A working drawing, with descriptive notes, is supplied with each permit. The makers of the fittings are Messrs. Smith & Wellstood, Ltd., Bonnybridge. Other ridge ventilators that may be mentioned are the well-known Boyle ventilator, and several makes of concealed roof ventilators. [C. W. S.]

Verbena (Vervain), a large genus of greenhouse or hardy annual, biennial, or perennial herbs or sub-shrubs (nat. ord. Verbenaceæ), nearly all natives of the New World. *V. officinalis*, the British species, used to be greatly esteemed medicinally. The half-hardy trailing garden kinds have not been so popular as formerly, owing to their liability to disease, but the advent of some fine new varieties is helping to restore them to favour. Seeds may be sown in heat early in the year; the seedlings are pricked out into small pots, being placed near the glass in an airy pit, and planted out about the middle of May. This method is less troublesome than keeping plants of named sorts through the winter to provide cuttings for striking in spring. The seeds may be purchased in colours—white, blue, scarlet, flaked, &c; a race named *compacta* may also be grown from seeds. Verbenas prefer an open position, and deeply cultivated and

liberally enriched soil. They should be grown in beds by themselves, and the colours may be mixed The shoots require to be stopped and pegged down. Miss Willmott (pink), Blue Beauty, Ball of Fire, Crimson King, Purple King, and Boule de Neige are excellent named bedding kinds. *V. venosa*, a semi-hardy perennial of erect growth with purple-blue flowers, is hardier and less liable to disease. Its seeds are slow to germinate: the fleshy roots are easily kept through the winter. [W. W.]

Vermin, a somewhat oldfashioned word used in various senses, three of which may be noticed here. (1) In reference to small mammals injurious to crops, *e.g* rats, mice, voles; (2) in reference to animals destructive to game, *e.g.* weasels and stoats, and birds like hawks and owls, (3) in reference to various ectoparasites, such as fleas, lice, birdlice, bugs, ticks, and mites For practical remedies and preventives special articles should be consulted, but four general statements may be useful (*a*) Excessive multiplication of rats, mice, and voles is sometimes due to extremely favourable weather conditions, or to the transportation of the rodents to a new territory, but it is usually due to undue severity in dealing with the natural enemies, vermin in the second sense (*b*) Killing off weasels, stoats, kestrels, owls, and the like is not wholly favourable to game preservation, since it is apt to lead to a weakening of the stock (see Grouse Disease) by the survival of weakly forms which would be eliminated in natural conditions. (*c*) The presence of vermin on the skin is usually the Nemesis of lack of cleanliness; though they pass readily from dirty to clean animals, they do not take such a hold of the latter (see Insecticides). (*d*) Many insects and Acarines obnoxious in themselves have an even greater importance as the bearers of disease-causing microbes [J. A. T.]

Vernal Grass, a sweet-smelling weed grass See Anthoxanthum.

Veronica (Speedwell), a large genus of greenhouse and hardy herbs and shrubs (nat ord. Scrophularineæ) with blue and, more rarely, rose-coloured or white flowers, widely dispersed, a number being natives of New Zealand. Sixteen species are natives of Britain, notably the beautiful *V. Chamædrys* (Germander Speedwell) and *V. spicata*, which are cultivated in gardens. The best herbaceous kinds include *V gentianoides*, *V. incana* (silvery foliage, used for bedding), *V. longifolia*, *V. prostrata*, *V. repens*, *V. rupestris*, *V. saturneæfolia*, *V. saxatilis*, *V. subsessilis*, and *V. Teucrium*. These are quite hardy, being readily increased by division, while some of them ripen seeds, and are excellent plants for the border or rockery The shrubby evergreen Veronicas are chiefly valuable in warm districts and for seaside planting, as they withstand wind and spray, and are very ornamental in winter and early spring. *V. Traversii*, 4 ft high, which has white or lilac flowers, is the hardiest; while *V. speciosa*, blue flowers, and its red- and white-flowered varieties attain considerable dimensions, and are the showiest of all. There are also a number of fine hybrids, such as *Andersonii*, *Kermesina*, *Lindleyana*, *versicolor*, &c., but they cannot be termed quite hardy, being liable to be killed in severe winters The smaller shrubby kinds, *alpina*, *Dabneyi*, *incisa*, and others, are good rock-garden plants They are readily increased by division. Many of the Veronicas are very variable. [W. W.]

Vertigo. See Megrims

Vespa, a genus of the Hymenoptera which includes the Hornet (*V. crabro*) and the Social Wasps. Of these latter there are several British species, the commonest being *V. vulgaris*, *V. rufa*, and *V. germanica*, which nest in the ground, and *V. sylvestris*, which builds its nest in trees. These insects attract the attention of agriculturists chiefly by their depredations on ripe fruit, to which they are sometimes exceedingly destructive. It should be remembered, however, that in their larval stage they are entirely carnivorous, and that, during a considerable part of the year, wasps are capturing insects, many of them highly injurious, to provide food for their young It is by no means certain, therefore, that their extermination is desirable, though it is often advisable to reduce their numbers. The females or 'queens' alone survive the winter, so that any of the insects taken in their winter quarters or in the spring are the possible founders of new colonies. Ground nests are generally destroyed by sulphur fumes or by gunpowder Cyanide of potassium is sometimes used, but is no more efficacious. [C. W.]

Vespidæ. See Vespa

Vetches, or **Tares** (*Vicia sativa*), sometimes called Lints, belong to the order Leguminosæ, and are sown on the farm in two varieties—the winter, for use in spring, and the spring, for use in autumn. There are few foods which are so useful on the farm They are admirable for horses—having been cut twenty-four hours before they are used, owing to their highly succulent nature—and for sheep, which are usually folded on a crop preferably as a mixture with oats or rye, which keeps them off the ground; while they are relished by both cattle and swine, although they are seldom needed by either Vetches may be sown as a catch crop in autumn, when, especially if well manured, they may be eaten off by sheep. They can be followed by a summer crop such as maize, cabbage planted out, or late turnips, or in spring after a winter crop is removed, when they make an excellent preparation for wheat, being in this respect similar to clover. Summer tares are usually sown alone, and either mown for forage for the horses, left for seed, or fed off on the land. On some occasions tares are ploughed under the surface, as green manure, enriching the soil in nitrogen, and supplying it with organic matter. In feeding tares as a green food it is important that an addition to the ration should be made in a form of food rich in starch, owing to the fact that they are rich in proteid matter, and they should not in consequence be used in conjunction with peas, beans, or cotton cake The most suitable foods for use with tares are maize meal or rice meal.

In sowing vetches it is usual to broadcast 4 bus. to the acre, or to drill 3 bus. It is not so essential to harrow down the land to so fine

a tilth for winter tares as for corn, but it is important that it should be free from wireworms, which sometimes destroy or partially destroy a crop. When sown with a cereal for spring consumption 3 bus. of seed are sufficient, together with 1 bus of oats of the winter variety or a similar quantity of rye. Vetches respond well to manure similar to that applied to beans (see BEANS), and produce a heavy crop on land of a great variety of types if it is in good heart, the usual weight of forage cut green sometimes reaching nearly 20 tons. A bushel of seed weighs about 64 lb., while the produce of a crop of seed may be placed at an average of 26 bus., with some 27 cwt of haulm Vetches may be regarded as one of the almost indispensable crops of the farm; useful as a catch crop, as a manuring crop, as a forage crop, especially advantageous for folding sheep and feeding horses in summer, and as a cleaning crop, for no plant is more useful in smothering weeds [J. Lo.]

Vetchling. See LATHYRUS

Veterinary Science.—It is hardly possible to exaggerate the importance to an agricultural community of anything which concerns the health of the domestic animals In districts where stock-raising is the chief industry, or where dairying is largely carried on, this is especially obvious; but even in tillage districts its importance is so great, that want of knowledge of the principles of veterinary hygiene may lead to losses almost as serious as those which result from bad harvests, or the adoption of obsolete methods in the matter of the cultivation of the land

This is especially to be noted where mixed farming is carried on, and where the holdings are of small size.

Thus, in many parts of the British Islands, where the average size of the farms does not exceed 15 acres, of which less than one-third is tilled, the loss of a good working horse or milch cow is a more serious disaster than the failure of the grain crop in any season Unfortunately, however, while most farmers realize the importance of striving to prevent the occurrence of those diseases which frequently have a fatal termination, it is not so generally recognized that there are a large number of diseases, not usually fatal, which result in equally serious, though not so obvious, a loss.

Thus, such diseases as contagious abortion in cattle, hoose in calves, ringworm, infestation by lice, indigestion in horses and cattle—with its numerous results, including broken wind, staggers, &c.—are too often, through ignorance or neglect, allowed to exist unchecked, with the result that serious loss is caused to the owner before he realizes the necessity for active steps. For the protection of the health of his live stock it is desirable that the farmer should have as thorough a knowledge as possible of his animals —their anatomy, the structure of each organ and its functions, how each organ does its work and how it can be deranged, and what steps should be taken to check disease on its first appearance

A favourite instance of the advantage of even a slight knowledge of anatomy is the case of the horse's stomach, which is remarkable among other things for its comparatively small size On account of this peculiarity, a well-informed horse-owner will realize that a horse's feeding should be given in small quantities and at frequent intervals; that long fasts are to be avoided; and that water should be given before feeding rather than after, so as to avoid washing undigested material from the stomach into the intestines

The means by which disease is spread from animal to animal, or from farm to farm, should also be carefully studied, even though this involves at least an elementary knowledge of pathology and bacteriology; and this becomes more and more important as we find that from time to time it is being proved that diseases are transmissible, directly or indirectly, from one animal to another, which within a few years past were supposed to arise in and be confined to the animal affected, or to be due to climatic or dietetic causes As instances of such diseases may be mentioned red water in cattle, and blackleg

PREVENTION OF DISEASE.—While there are special precautions to be adopted for certain diseases, the following general principles should be observed in all cases 1. *Cleanliness* is an absolute essential, as neglect of it not only encourages the growth and reproduction of many of the most dangerous disease germs, but also tends to lower the vitality of the animal and its power of resisting disease. This cleanliness applies to houses or sheds, to the bodies of the animals, and even to the pastures on which animals graze, as shown by outbreaks of disease where cattle are crowded or left too long on a pasture

2 *Fresh air* is nearly as necessary as food, because the blood on which life depends cannot be healthy unless the lungs are provided with an ample supply of fresh air, the latter being also the foe of many germs of disease.

3 *Light* is desirable, both as hostile to the germs before mentioned, and as a natural stimulant to the vigour and disease-resisting power of the animal.

4 *Suitable food* in carefully calculated quantities has an important bearing on the preservation of health, the proper choice of feedingstuffs being much assisted by a knowledge of the anatomy and physiology of the digestive organs of the respective animals. Thus, it is obvious that it is not proper to feed a horse, which has a simple, small, pouchlike stomach, capable of holding less than 3 gal., on the same quality or quantity of food per meal as an ox with four stomachs, with a capacity at least fifteen times as great, and with the ability to regurgitate food for more thorough mastication.

5. *Isolation* of sick animals can scarcely be too strongly urged, even though the disease may not be recognized as infectious or contagious, for reasons already given. Animals suffering from disease should not even be allowed to graze on pastures with healthy animals, certain fields becoming infected from their occupants with such diseases as fluke, parasitic scour,

hoose, abortion, &c. It may be noted, however, that where a disease affects one species only, it is often useful to graze an infected pasture with animals of another species, not liable to the disease, for a sufficient period to enable the disease to die out. Thus, on land where red water in cattle frequently appears, it will be found that if the pasture in question be used for horses only, for a year or more, it will be found that, unless the disease is again introduced, the land has become safe for cattle as regards red water

Diagnosis of Disease – It is essential that every farmer and stock-owner should be able to recognize the general signs of health or disease, and, as a matter of fact, considerable skill is usually attained by practical experience; but it will be of the greatest advantage to train the powers of observation in the light of the general study of anatomy, physiology, and pathology (disease) which has been already recommended.

Health has been defined as 'that condition of an animal or organ which is found to be most common on an examination of the greatest possible number'. That is, health is the natural, normal, or usual condition, so that anything unusual in an animal or one of its organs, any change of habits, of appearance, of gait, &c., should at once be made the subject of enquiry, since such outward manifestations may be signs of serious internal changes due to disease Thus, an experienced stock-owner, noticing a certain wild staring appearance in the eye of an ox, will have his suspicions aroused; and if he notices in addition even a slight change of gait, he realizes that there is serious digestive trouble, which if not at once checked will lead to the serious nervous affection known in most districts as 'staggers'. In judging as to the health of an animal the farmer should take into consideration the following points.—

1 The general appearance of the animal, such as a bright, lively eye, healthy or even glossy coat, especially in horses, skin moving freely over the ribs, a tendency to keep in the company of its fellows.

2. The appetite.

3. The quantity and nature of the excreta, both urine and dung.

4. The rapidity and other peculiarities of the breathing.

5. The external temperature, as ascertained by feeling horns or ears, and the internal temperature, tested by the insertion of a clinical thermometer into the rectum.

6 The pulse.

Evidences of disease can frequently be noted under the foregoing heads, by one or more of the following signs:—

1. An animal may be noticed shunning the company of his fellows, standing with head drooped, arched back, staring coat, hidebound, eyes dull and sunken.

2. The appetite may be suspended or fickle, sometimes excessive and at other times very small; while in some cases there may be a desire to eat strange substances or even filthy matter, such depraved appetite being known under the name 'pica'.

3. Either constipation or diarrhœa are obviously signs of disease of more or less importance, and when noticed, show need for further observation and enquiry

4. Very rapid breathing, unless when due to recent exertion, will suggest the existence of pain or disease.

5. Elevation of temperature will show the presence of fever; while depression of the same below normal suggests weakness, and in marked cases may herald approaching death

6. Rapidity of pulse shows excitement or recent exertion, but it also accompanies pain and fever; while a slow pulse may indicate weakness, either systemic or of the heart itself

There are many varieties of pulse which can only be recognized by those who have frequent opportunities of practice at diagnosis, and a complete knowledge of the circulatory system of the animal body.

When the stock-owner has arrived at the conclusion that disease is present in an animal, his next endeavour should be to ascertain (*a*) the organ or organs affected, (*b*) the nature of the disease, *i.e.* whether infectious or contagious or not; (*c*) the extent or seriousness of the attack. It will be convenient here to consider some of the commoner diseases of farm stock and matters in their connection likely to be useful to stock-owners.

The diseases which most commonly give trouble to stock-owners may be classified as:—

A Those arising in the digestive tract, including stomach, bowels, and liver.

B Those which appear in the respiratory tract, including nose, throat, and lungs.

C Those in the urino-genital tract, including kidneys, bladder, ovaries (whether pregnant or otherwise), and in the male, testicles and penis.

D Those on the surface of the body

E The results of accident, including bruises, wounds, fractures, &c.

F Lameness

Under the heading A we will first consider the following —

Indigestion in the horse is generally due to errors of feeding. The horse requires food of the best quality, in small quantities and often, water before food rather than after; and in cases of unavoidable long fasts while working, the animal which has become more or less exhausted should not be allowed a heavy cold drink, but a small lukewarm nutritive drink, such as thin gruel, or bran water. This calls the digestive organs into action, and food may then be allowed. Indigestion of a chronic kind, due to excessive feeding, or the allowance of too much bulky food, leads to 'broken wind', which is, in part at least, due to the intimate connection between the digestive and breathing apparatus in the horse.

Defective teeth must be mentioned among the causes of indigestion, as also other affections incidental to dentition, *e.g.* swollen gums and the congested condition of the roof of the mouth known as 'lampas', which, however, is often rather a result than a cause of digestive disturbance. In young animals it is sometimes found that the temporary grinding teeth are not duly 'cast' at the proper time, so that the crowns

persist, and being thrust out of position by the outgrowing permanent teeth, make proper mastication difficult or impossible. Such crowns require removal, which is usually effected with a forceps or tooth chisel.

In aged animals, horses especially, it is not uncommon for mastication to be interfered with by sharp edges or points on the grinders (molar teeth) caused by unequal wear. In this connection it should be remembered that as the upper jaw of the horse is wider than the lower one, the troublesome projections will be found on the outer edge of the upper teeth, that is, against the cheek, which they sometimes lacerate; while in the lower jaw the inner edge is the one likely to give trouble, coming in contact with the tongue. These irregularities are got rid of without much difficulty by the use of a specially made tooth rasp, which has a smooth back and rounded edges to avoid injury to tongue or cheeks, and is 'cut' on its concave side. It is generally advisable to put a twitch on 'grin' on the upper lip of the horse to be treated; the tongue should be gently but firmly grasped by a careful attendant who can be depended upon not to pull unduly at the tongue, and the rasp is sharply applied.

Lampas and similar conditions are best treated by a cooling laxative diet, with in some cases small doses of salts; and where the patient appears to eat with difficulty, lancing may be resorted to. Burning the roof of the mouth, as formerly practised, is both useless and cruel

Colic in the horse may be due to acute indigestion or to other causes, but it is a term freely used to signify any acute painful affection of the abdominal organs, whether stomach, bowels, liver, or kidneys.

It is not always easy, even for an expert, to differentiate between the various forms of colic, the symptoms being in many respects similar.

The farmer, therefore, whose horse shows signs of severe abdominal pain, if in doubt as to its exact nature, should, in the absence of a veterinarian, first of all try and ascertain if anything has occurred recently which will throw a light on the origin of the attack. Thus, if the animal has been recently watered while hot and tired after exertion, the pain usually has its seat in the intestines; while in the case of a mare which, as frequently happens, is shy of passing urine while in harness, it may be found that the distress arises in the bladder through too prolonged retention of urine.

In the latter case the simple operation of passing the catheter gives instant relief; while in the former case stimulants are indicated, with a laxative such as linseed oil. If no drugs are available, relief is often given in ordinary cases of colic by the administration of a few glasses of good whisky in an equal quantity of cold water, or a quart of warm stout or ale with ½ oz. of ground ginger. A safe colic draught, which may be kept in stock and given even to pregnant mares, is made as follows: 1 oz. of laudanum, 2 oz. sweet spirits of nitre, ½ oz. ground ginger, ½ pint linseed oil. Colic is often due to the presence of internal parasites, in which case, after relieving the acute symptoms, *worm medicines* are advisable. In this connection good feeding is essential, as internal animal parasites of all kinds flourish best, and produce most serious results, in badly nourished animals. For this reason, tonics such as sulphate of iron, in daily doses of 30 gr., are of great use in treating horses so infested, especially if followed, after the first week, by a dose consisting of 1 pint of linseed oil and half a wineglass of spirits of turpentine, mashes being given for twenty-four hours before the administration of this drench

Indigestion in cattle most commonly arises in the first, third, or fourth stomachs, and may be due to excess as to quantity, or defective quality of food. Deprivation of a sufficient supply of water may also be a cause. Among the various forms of indigestion in cattle may be mentioned impaction of the first stomach or rumen, which frequently occurs where cattle get access to bins or other receptacles where food is stored. Treatment here will vary according to the nature of the food, in some cases removal by operation being necessary, which operation, needless to say, will require the skill of an expert. Where fermentation takes place, leading to the formation of gas, there will be great distension of the rumen, in some cases rendering puncture of the rumen through the left flank necessary. In all these cases food will be withheld, liquids being allowed, and digestive stimulants, including various forms of alcohol and preparations of nux vomica, being administered.

The third stomach may become impacted through a variety of circumstances, *e.g.* as a result of imperfect preparation of the food by mastication and rumination, and it is a frequent complication of certain febrile diseases, notably 'red water'

The fourth stomach, which is the true stomach, may be affected similarly to that of the horse, and is also liable to become inflamed through the action of parasites, both animal and bacterial These affections of the fourth stomach usually also involve the intestines, and are as a rule accompanied by diarrhœa

In all cases of impaction it is found necessary to administer purges; but it is not advisable to depend too much on powerful doses of any one drug, better results being obtained by the use of a mixture of various drugs with different kinds of action, or the repeated use of such remedies as calomel in dram doses several times daily, or linseed oil similarly used in moderate doses

The liver of the horse is less liable to disease than that of cattle, but suffers severely from the attack of certain forms of influenza Where jaundice is present, as shown by a yellow tinge of the mucous membrane of the eye, a cathartic is generally found efficacious, either a physic ball being given, after due preparation by soft feeding for the preceding twenty-four hours, or calomel administered in dram doses, twice daily, until satisfactory evacuations have been obtained.

The liver in cattle is liable to many affections, a large number of which are due to animal parasites. Perhaps the best known of these parasites is the fluke, a flatworm which in its mature state inhabits the bile ducts of the liver.

It also attacks sheep, producing the condition known as 'rot' or 'liver-rot'. Like some other parasites it spends only portion of its life-cycle as a parasite in the liver of sheep and cattle, one stage of its existence being passed as a parasite of a species of snail which inhabits damp pastures, and at another stage it is found encysted on the blade of grass with which it is picked up by cattle and sheep.

Treatment is not satisfactory when the parasites have gained access in any numbers, but attention to drainage of pastures, and the use of lime and salt as topdressing, are recommended as likely to get rid of the snail which is necessary to the perpetuation of this parasite

Bladderworms frequently occur in or near the livers of cattle, the commonest one being one stage in the life of a parasite which in another stage occurs as a tapeworm in the dog

No medicines can avail against these bladderworms once they have reached their habitat in the liver, but it is probable that the administration of salt in the food would have a certain preventive effect The proper step, however, is for the stock-owner to insist that every dog, so far as possible, which has access to the land shall be treated at frequent intervals for the eradication of tapeworms

This course would also lead to the suppression of the disease known as 'gid' or 'sturdy', which is also due to a bladderworm, technically known as a hydatid, in the brain of the sheep, the alternate stage being a tapeworm in the dog

Scour or diarrhœa is perhaps one of the commonest troubles in the case of young stock, and arises from a variety of causes In foals and suckling calves the cause is usually in the mother's milk, where some chemical or other change may have taken place, owing to some irregularity in the digestive system, or to some neglect, such as keeping a mare and foal too long apart without milking the former. Any sudden change of food will affect the milk of mares and cows, causing scour in their offspring

In hand-fed animals, however, such as the large majority of calves which are fed from a pail, the disease may be due to the following causes among others —

(1) Neglect to give the calf some of its mother's first milk or 'biestings', which is necessary in order to clear the intestines of the 'wax' or meconium which has collected there before birth, being practically bile.

(2) Too long intervals between meals, in the case of young calves, is a frequent cause of digestive disturbance from which scour or other troubles may result.

(3) Dirty vessels for storing calves' food may often be blamed, as also (4) sour or decomposing food, and (5) certain calf meals.

(6) Infection from other calves leads to one of the most serious forms of scour in young calves, the name 'white scour', or *Dysenteria alba*, being generally applied It is held that infection here takes place through the umbilicus (navel cord) either soon after or at the time of birth, though some authorities hold that infection may take place before birth.

Prevention and Treatment of Scour.—Strict attention to cleanliness and all the general principles of hygiene already set out will be absolutely necessary, feeding being carefully attended to, and the causes just enumerated avoided Calves should be fed on whole milk, and not skimmed or separated milk, for at least one month after birth, and if a calf meal is used, the stock-owner should select one which is known to contain the necessary constituents of a food in suitable proportions The Department of Agriculture recommend a mixture consisting of pure crushed flax seed 1 part, fine oatmeal 2 parts, and fine Indian meal 2 parts As a preventive of infectious scour, the navel cord should be tied up with a piece of twine which has been soaked in disinfectant, the navel cord itself being first washed with disinfectant, and finally smeared with some protecting material such as collodion, or even so simple a thing as Archangel tar As a further preventive of this form of scour, where the latter is prevalent the young animal may be drenched with a preparation known as pankreon, which is sold in tablets with full printed directions as to its administration

Among the simple remedies recommended in ordinary cases of scour in young animals the following course may generally be followed with success (1) A dose of castor oil, varying from half a wineglass to two wineglasses, should be given when the attack is first noticed. (2) Half a wineglass of brandy, with a wineglass of port wine and two raw eggs beaten up together without the egg shells (3) The feeding should be restricted to boiled milk (4) At intervals the following substances may be given as found convenient starch, up to ¼ lb., chalk, up to 1 oz.; oil of peppermint, 1 teaspoonful in a little water with the chalk.

Laudanum and chlorodyne are frequently used in doses of from 5 to 60 drops In the case of young animals which are suckling their dams it will be well to depend chiefly on treatment of the dam, who should receive a full dose of castor oil or linseed oil, followed by a complete change of food

Constipation, as distinct from impaction, which has been already treated of, may arise from various causes, and generally indicates the necessity for a change of diet, laxative substances being selected. When a purge is found to be necessary, it should be remembered that in the case of the horse it is always advisable to give a course of preparation if possible; and if not, the purge selected should be one of the bland oils

Where a horse can be prepared for a purge by twenty-four hours of laxative diet and plenty of fluids, an aloes ball is generally given, the dose varying from 4 to 10 dr. according to the strength of the animal and to the particular locality, horses in certain districts requiring far larger doses than those in others. In cattle, preparation is not so necessary, but here also the effect of the purgative dose is aided by the free allowance of water before and after the administration of the medicine A dose very frequently used is the following. 1 lb. of Epsom salts, ¼ lb. of common salt, 1 oz. of ground ginger,

1 qt. of stout or ale, to which mixture may be added one or more pounds of treacle thinned with hot water, the whole forming a lukewarm drench.

Tympany, or the collection of gas, may be met with in all animals, and has been referred to in speaking of 'indigestion' above. In cattle it is known as 'hoven', and is most frequently noticed in the left flank, the gas or 'wind' being in the first stomach or rumen. In horses it usually shows most plainly on the right flank, the large bowels being here involved.

An operation is sometimes necessary; and though it should be avoided where possible, and, unless in cases of great emergency, should only be performed by an expert, it is sometimes necessary for a stock-owner to give immediate relief in this manner. The risk of bad results is not so great in the case of cattle as in horses: but in both the simple rules should be adopted -(*a*) to puncture in the most prominent part of the swelling; (*b*) not to operate too high, *i.e.* too near the backbone; (*c*) to keep fairly equidistant between the haunch bone and the last rib; (*d*) to direct the instrument downwards, inwards, and slightly backwards.

The instrument best adapted for this purpose is known as a trochar, being practically a dagger It is used with a tube called a canula, through which it is passed, and the two together can be driven through the abdominal wall into the stomach of the ox or the intestine of the horse, the trochar being then withdrawn, leaving the canula in position, and through the latter the confined gases at once escape, the canula being retained in position until relief is obtained The trochar used for the ox is usually larger and coarser than that used for the horse.

In cattle, where no proper instrument is available, relief is sometimes obtained by the use of a knife alone, which, after being thrust into the rumen or paunch, is slightly rotated, thus causing the incision to gape somewhat, and permitting the gas to escape Before resorting to operative interference, however, it is always well to try the effect of a smart stimulant, *e.g.* a few glasses of good whisky; while good results may also be frequently obtained by the administration of a moderate dose of linseed oil with turpentine

In chronic cases of tympany in cattle, or where there is a tendency to a recurrence of hoven, it is sometimes found that the cause may be traced to one of the forms of tuberculosis, which disease is not curable

Choking may be considered here very conveniently, as it sometimes involves both the alimentary and respiratory tracts. It occurs more frequently in cattle than in any other animals, and is generally due to the lodgment of some object, such as the crown of a turnip, in the gullet. When it occurs, a rounded piece of wood a few inches thick should be placed across the mouth, with its ends projecting a few inches on either side of the face. It should be secured by a cord over the head, and left in position for a few hours, often leading to relief. In some cases, however, it is necessary to pass the probang or 'choke-rope', a leather-covered flexible tube made for the purpose, and requiring very great caution and considerable skill in its use, or serious injury may be caused. This instrument is passed into the mouth and along the tongue to the back of the throat without any force, when the animal usually draws it in by a swallowing motion until the obstruction is reached, when some force has to be used, but with great discretion. One precaution to be remembered is that the operator should never stand with his back near a wall, or other fixed object, lest the patient should thrust forward, so as to cause the instrument to strike the wall or post, &c., which would almost certainly have a fatal result

Diseases of the respiratory organs include some very common affections, such as common cold, cough, sore throat, and certain parasitic diseases, including hoose or husk. There are also certain infectious diseases which frequently affect these organs, notably various forms of influenza and strangles

It is not always easy for the stock-owner to distinguish between these various forms of throat and lung troubles, especially in the earlier stages of disease, so it is well on all occasions to use precautions against danger of infection when a cough manifests itself Though a cough or cold is not in itself necessarily serious or important, it should never be neglected, as it may be the precursor of a more serious affection In all respiratory diseases it is a first essential that the patient be kept under the very best sanitary conditions. A good supply of pure air is absolutely necessary; and where this is wanting, recovery is delayed and other complications may be feared. It is probable that many cases of defective respiration, such as 'whistling', 'roaring', &c, are caused by keeping horses in close, badly ventilated houses while suffering with coughs, colds, strangles, or influenza. A fair amount of warmth is desirable, but should be secured rather by means of clothing, hoods, and bandages than by closed doors or windows.

Feeding in all such cases is important, as strength must be maintained, though dry food is unsuitable for various reasons. Green food, where available, should always be given, at other times roots being substituted, carrots being particularly suitable Boiled flaxseed in conjunction with mashes or gruel is soothing to these and other internal organs.

Where a cough is present, it is usually beneficial to apply stimulating liniments or mustard to the skin outside the throat Purges should be avoided in the case of horses with acute respiratory troubles.

Sore throat in its commonest form is also known as 'pharyngitis'. It is accompanied by a soft cough, difficulty in swallowing, discharge from the nose, sometimes food and drink being returned by the nose, and tenderness on pressure of the throat even if this be applied gently.

In cases of this kind the foregoing general suggestions should be carried out, but as far as possible the forcible administration of food (liquid) or medicine should be avoided. Unless there is much fever, as shown by a temperature of more than 104° F., it will be generally sufficient

to apply a liniment to the throat, and repeat if necessary; to follow out the other directions just given; and as medicines to depend on simple salines, which may be given in drinking water or made into an electuary with treacle or honey. Thus 2 oz. of nitrate of potash may be mixed with ½ oz. of chlorate of potash and ¼ lb. of treacle. About a tablespoonful of this mixture may be placed on the horse's tongue or back teeth three times per day. To this some persons add belladonna, which, however, has the disadvantage of spoiling the appetite.

Great relief is often obtained by steaming the patient's head, which can be simply done by half-filling a sack with hay loosely packed, drawing up this sack on the horse's head and fastening there to the head-collar, and allowing the lower part of the sack and its contained hay to lie in a bucket of boiling water, so that the steam rising through the hay is breathed by the horse, the hot water being frequently renewed The addition of a mild disinfectant to the hot water is a useful practice, *e.g* 1 oz. terebene. After steaming, the animal should be protected for some time against exposure to cold air.

Laryngitis furnishes another form of sore throat, there being here inflammation at the upper part of the windpipe. As the affected part may be said to be enclosed in a box of hard gristle or cartilage, there will not be the same amount of tenderness on pressure, the cough will be harder, shorter, and more frequent, the mucous membranes of eye and nostril often bright-red, and the temperature very high Treatment in this disease is much the same as in the former; but such cases need great care and skill owing to the danger of the air passage becoming closed and suffocation ensuing, which often can only be prevented by the operation of tracheotomy.

A favourite remedy in laryngitis is tincture of aconite, given in half-dram doses of the B.P. tincture twice a day in the drinking water Bicarbonate of soda may also be added in half-ounce doses to the drinking water

A useful recipe for a stimulating liniment to be used in this and other affections is the following —

LINIMENT FOR OUTWARD APPLICATION

1 wineglass of strong ammonia
2 wineglasses of water.
3 wineglasses of sweet oil
1 wineglass of turpentine.

Mix in the above order, shaking the bottle while mixing. A small quantity of sweet oil smeared over the part to which the liniment has been applied will prevent the hair being cast This may be done an hour after rubbing in the liniment.

Influenza in horses is a disease which appears in several forms, the symptoms, course, and organs affected varying considerably. The treatment will depend on the special form it may take, but the lines laid down in the respiratory diseases already treated on may be followed. In this disease, however, it is essential that complete rest be allowed, good nourishing but laxative food, and a fair quantity of alcohol in the form of good whisky. Purges must be avoided, enemata being used to relieve constipation, and starch where diarrhœa is present.

Strangles is an infectious disease, most commonly met in young horses, in which there is usually a considerable amount of systemic disturbance, accompanied by many signs of general illness, the chief local manifestations, however, being sore throat, accompanied by a swelling of one or more glands in the same neighbourhood. The swellings here referred to most usually occur in the space between the jawbones, though frequently the swelling extends up on each side towards the ear, and occasionally these 'strangles abscesses', as they are called, occur in more remote parts.

The treatment will include all the precautions already suggested for infectious diseases, including isolation, disinfection of buildings and clothing, and reserving special buckets and brushes, &c, for the patient.

The treatment laid down for sore throat will be appropriate, but in addition the swellings should be frequently fomented with hot water or poulticed with linseed meal In consequence, however, of the difficulty of securing efficient fomentation or satisfactory application of poultices, blistering the swellings is commonly resorted to; and when the abscess ripens, or, to use the common expression, it 'points', lancing is often advisable In this disease, as in some forms of sore throat, it is necessary for the horse-owner to realize that there is always a danger of suffocation or other complications, so that the attendance of an expert is desirable, especially in the case of valuable animals

Bronchitis is an inflammation of the small tubes in the lungs which carry the air from the windpipe to the air cells where the blood is purified The form of bronchitis which is most commonly met in the domestic animals is due to the presence of certain small worms, their eggs, and young These are of several kinds, some of comparatively large size, others thread-like, and others microscopic Calves and sheep appear to be the chief sufferers, but wild animals, and even poultry, may also be attacked.

Hoose or husk is the name by which parasitic bronchitis is usually known, causing serious loss to stock-owners, especially among calves, since even when the disease does not prove fatal there is great loss in condition, so that animals may arrive at two years old with the size and appearance of yearlings.

Certain pastures are known to be badly infested by these parasites; and this condition is perpetuated where the owner of calves allows those animals which are suffering with these parasites to continue to graze over the field, their discharges further spreading the contamination The chief symptom is a persistent irritating cough, attended by emaciation, and in some cases by diarrhœa, the cough usually beginning in autumn—hence a name sometimes used, 'harvest cough'—and continuing till the following summer, unless the animal succumbs in the meantime.

Treatment consists of (*a*) drenches, (*b*) fumiga-

tions, (*c*) injections. The drench most frequently used consists of a mixture of linseed oil and turpentine, 2 parts of former to 1 part of the latter, the dose being about half a wineglass, less or more according to size, given daily, fasting in the morning for a week. The fumigation is carried out by causing the patient to breathe the fumes of burning sulphur, and may be done in a small close apartment to a number collectively or one by one, by means of a bucket at the bottom of which the sulphur is burned on some live red coals. Care and discrimination are required to avoid overdoing the operation. The injection requires some practice, and is performed by means of a syringe, with a hollow needle attached, through which various preparations are injected through a puncture direct into the windpipe. Each practitioner has his own fancy, but a mixture of glycerine 4 parts, turpentine 2 parts, and carbolic acid 1 part, used slowly in small quantities, is effective.

Pneumonia, which is inflammation of the lungs, and *pleurisy*, which is inflammation of the membrane which lines the chest, are diseases which require the prompt attention of a qualified veterinarian. Either of these affections may occur as complications of influenza

Whistling and roaring have already been mentioned and are practically incurable, but an operation is sometimes successful. See art. Tracheotomy.

The urino-genital tract consists of those organs concerned in urination and breeding

The kidneys and bladder sometimes give trouble, especially in horses, but many cases of supposed urinary trouble are really due to pain in the intestines, it being frequently noted that a horse while in pain persistently retains urine, but on getting relief immediately evacuates urine freely. Hence many people wrongly blame the retention as the cause, in cases where it was rather an effect of internal pain.

Where kidney or bladder trouble is suspected, mild diuretics, such as sweet spirits of nitre, or saltpetre, may be given, but powerful irritating remedies should be avoided. The too frequent use of diuretics often contained in condition powders may lead to the condition next described.

Diabetes, or diuresis, in veterinary practice generally means profuse flow of urine. Some forms of diabetes are very serious in their origin and consequences, needing professional treatment; but in the more common forms it is often sufficient to put an end to certain mistakes of diet and management in order to cause cessation of the troublesome symptoms, which, if not checked, will be followed by great loss of condition and weakness. A dose of laxative medicine is always useful, together with a change of diet, such things as new hay or oats being avoided. The administration of iodine puts an end to the excessive thirst, and is usually one of the most successful parts of the treatment in this condition; but it must be noted that iodine can only be safely given in the form of a ball or pill, carefully prepared by a chemist, in doses of 1 dr. daily. Iodine must never be an ingredient of a drench or serious results may follow, owing to its action upon the lining of the throat.

Diseases incidental to breeding are numerous, among those most common and important being abortion, which has been already considered, sterility, which is often a form of contagious abortion in cattle; inflammation of the womb; retention of the afterbirth; milk fever, which is treated in a previous volume; mammitis, or inflammation of the udder, also sometimes known as garget.

In connection with breeding, the following matters require earnest attention.—

1. Breed only from animals, male or female, which are in every way physically fit, being free from hereditary disease, and having the necessary conformation in the female to ensure sufficient room to carry young till full time, and to produce same without difficulty, many mares and cows and their young being endangered, at the time of parturition, where the dam has a narrow pelvis. Very old sires and dams as a general rule should not be used.

2 Pregnant females should be carefully guarded from violent exercise or other disturbing influences

3 Strict attention must be paid to hygiene all through the period of pregnancy and afterwards, as such diseases as abortion, metritis, and mammitis are often due to insanitary surroundings

4 Due precautions should be taken before the time arrives when the young may be expected, that parturition may take place under suitable conditions, thus a mare, unless in summertime, should be provided with a roomy box, and a cow should, where possible, be separated from others Various steps may be taken to prevent the female animal from lying with her hind extremity near a wall or partition, so that the exit of the young may not be prevented This is particularly necessary in the case of the mare, which usually has a rapid delivery, and in this animal delay is more serious than in the case of a cow. As examples of such steps may be mentioned the suspending of bundles of straw along the walls horizontally a few feet from the ground, and timber poles in the case of sows a few inches from the ground.

5. While assistance should be at hand if required, and a careful supervision carried on, there should be as little interference as possible, especially in the very early stages of parturition.

6 When the vesicles or 'water bladders' appear they should be left intact as long as possible, as the fœtus is then being floated into the passage, which is being naturally dilated by the membranes distended with fluid, and premature puncture of the 'bladders' will allow the escape of the fluid, often before the proper position has been attained, and many cases of difficult birth are thus caused.

7. Assistance should only be given by an experienced person, with hands and arms absolutely clean, and where obtainable a disinfectant should be used.

Retention of the afterbirth or 'cleanings' is not common in mares, but where it occurs it is more serious than in cows, and necessitates prompt

removal by hand. In cows, owing to the fact that the membranes are attached to a number of prominences called cotyledons, or more commonly 'roses' or 'dogs', there is more danger of retention occurring than in the mare; but in the latter the consequences are more likely to be serious, as the attachment is over the whole interior lining surface. If freshly calved cows are allowed from ½ lb. to 1 lb. of Demerara sugar dissolved in warm ale night and morning until an aperient effect is noticed on the excretions of the bowels, 'cleaning' usually takes place satisfactorily. If, however, removal by hand becomes necessary, this should only be done by inserting the hand and gently unfastening the attachments from each cotyledon separately. If general health is maintained this need not be performed so long as the neck of the womb remains sufficiently open to permit the easy passage of the hand

Metritis, or inflammation of the womb, may arise from injuries during parturition, but more frequently from neglect of some of the precautions suggested above, and its treatment calls for skill and great attention. Weak disinfectants are usually injected into the womb, such as perchloride of mercury of a strength of 1 part in 1500 parts of clean lukewarm water, or a pessary may be obtained from a chemist, containing 15 gr. of chinosol in 100 parts of excipient, such pessary being really a large pill, which is thrust into the womb and left there, and repeated at suitable intervals—at least once daily Fever medicines and blood medicines are also necessary, for which the stock-owner may use saline purges, and among other drugs hyposulphite of soda in doses of half an ounce three times a day. The condition is so serious that veterinary help should be early sought

Treatment of the newly born animal has been already described under the heading 'White Scour'.

Inflammation of the udder in cows may arise from injury, or exposure, or careless milking, but frequently is due to infection where surroundings are insanitary, or where the attendant milks an animal with hands contaminated by a cow already suffering. These infectious cases are exceedingly troublesome to treat, and often result in the loss of a quarter or more, in some cases the cow's value as a milk producer being quite destroyed, and even her life being in peril.

Treatment consists of fever medicines as advised in metritis, with almost constant fomentations. The latter should be as hot as the hand can comfortably bear, the udder being supported with canvas where much swollen. A useful application, to be well rubbed in with gentle pressure but little friction, is a mixture of camphorated oil 8 oz., and sulphuric ether 2 oz., to which may be added tincture of belladonna ½ oz This quantity is sufficient for several applications, being used after the fomentation twice daily. The udder must be kept well drawn, and in case of obstruction it may be necessary to introduce a teat syphon, but this must be boiled before being used on each occasion.

In the mare, inflammation of the udder may be due to keeping dam and foal too long apart, or where a foal, through sickness or other cause, does not suck.

Frequent fomentations are here necessary, liniment as above may be used, and internally ½-oz. doses of hyposulphite of soda twice daily, the milk being frequently drawn.

In male animals the commonest troubles arise from either injuries, infection, or new growths, all of which require surgical attention as a rule.

Skin diseases in the domestic animals form a very numerous class, including those due to animal parasites, such as mange, and infestation by lice, and by vegetable parasites, such as ringworm.

Most of these have already been treated on, so that it will be sufficient here to emphasize the importance of strict cleanliness in the case of housed animals, and precautions against infection in all animals.

Sufficient importance is not ascribed by many stock-owners to the dangers which arise from the unchecked presence of animal parasites, such as ticks, which convey serious diseases, and lice, which cause anæmia, wasting, &c. On horses lice can be easily got rid of by applying, with a brush, raw linseed oil over the whole body and legs.

For cattle and pigs, a useful lotion is made by boiling 4 oz. of staves acre seeds in 1 gal of water, which may be freely applied externally.

Warts and other growths usually require surgical removal, but when small often disappear if rubbed daily with castor oil or a strong solution of washing soda.

Diseases of the feet in horses and cattle have been already treated under various heads, but too much stress cannot be laid upon the importance of the care of the horse's foot, as it is often said, with much truth, 'no foot, no horse'

Very careful supervision should be exercised over the shoeing of horses, such errors as rasping the surface of the foot wall and cutting away the 'bars' being avoided Some results of bad shoeing are met in such conditions as 'corn' and quittor, the latter being one which requires frequently a serious surgical operation for its removal The disease known as canker is one which also requires the skill of a veterinary expert Thrush is a common disease, partly systemic in its origin, but favoured by dirt and bad shoeing It should be treated by daily applications of a mixture of Archangel tar and salt, but some cases yield readily to daily applications of calomel well rubbed in.

The results of accidents are very numerous, those to be considered here being local inflammations due to sprains, bruises and wounds, &c

Sprains of joints, ligaments, tendons, or muscles should never be neglected Even while awaiting the arrival of the veterinary surgeon no harm can result, but probably much benefit, from the persistent application of hot fomentations (not scalding). Sometimes benefit is derived after a time by a change to cold applications, such as a stream of cold water from a hose.

The application of a mild stimulating liniment, such as given under respiratory diseases, often has good results. In more severe cases, after the acute inflammation has been reduced it may be necessary to apply a blister, which usually

consists of a mixture of such a substance as cantharides, or biniodide of mercury, or both, mixed with lard or oil in the proportion of 1 of the irritant substances to 6 or 8 of the lard or oil. Bruises may be treated on similar lines, but when suppuration takes place it may be necessary to lance any abscesses which form, after which the treatment becomes rather that of wounds. In dealing with wounds, too much attention cannot be given to cleanliness.

It is not so necessary as many people seem to imagine for man to try and help healing by his medicines and applications, as it is to allow nature free play without interference by disease germs.

Unless there is much bruising or contusion, it is not desirable to do too much in the way of fomentation.

Any dirt or other foreign material should be carefully removed, the water and whatever else is used being absolutely clean; and if a sponge is used, the latter should be first boiled or otherwise disinfected. To the water used to clean a wound an antiseptic may be added, which means anything which will kill disease germs without injury to the patient.

Among antiseptics may be mentioned perchloride of mercury, which is a powerful poison and should be used with extreme care, generally at a strength of 1 in 500 to 1 in 1000; carbolic acid, used at a strength of from 2 to $\frac{1}{2}$ per cent, permanganate of potash, at a strength of $\frac{1}{2}$ per cent, and many other excellent preparations, including lysol and chinosol.

The stock-owner, however, must clearly distinguish between the use of antiseptic treatment, which is intended to counteract the presence of germs which ought not to be present, and aseptic treatment, which means endeavouring to prevent the access of contamination. The latter should always be the chief endeavour. An application of friar's balsam to a recent cut fulfils both purposes.

Where needles, silk, bandages, lint, wool, or instruments have to be used, these should be absolutely clean and free from contamination, *i.e.* aseptic; and it is to secure this condition that the so-called 'antiseptics' are used, and not to hasten the healing process, which depends on nature, on the health of the patient, and the conditions under which the latter is kept.

After a superficial wound has been thoroughly cleaned and rendered aseptic, it is generally better to avoid the excessive use of fluid applications, such substances as dry boric powder freely applied on the surface being generally satisfactory. In deep penetrating wounds, however, it is sometimes well to avoid too early unition of the external opening, and here even syringing with an antiseptic may be found advisable.

In one special case, that of 'broken knees' in horses, some practitioners claim the greatest success from the use of cold water, which, by an arrangement of a small rubber tube fixed to the patient's leg above the knee, they cause to flow continuously over the injured surface.

One of the most serious forms of wound is that known as 'open joint'; yet if asepsis is maintained, it is frequently found that ordinary slaked lime freely dusted on the wound many times daily, and allowed to remain there, causes most satisfactory results.

Friar's balsam, already mentioned, is antiseptic, and also forms a protective coating over the surface of a cut or abrasion.

Lameness is one of the most difficult matters with which the student of disease in animals has to deal, and its diagnosis requires wide experience based on thorough knowledge of anatomy and physiology.

A safe rule in every case of lameness in a horse is to suspect the foot until it has been properly examined, for which purpose it may be necessary to remove the shoe and 'search' the foot with a 'drawing knife', such as is used by all farriers. Tenderness may be detected in some cases by tapping with a hammer, and in other cases by squeezing the edge of the foot at different points all around with a farrier's pincers. If it is found that the foot is not the seat of trouble, expert advice should be sought at once, as, in the case of lameness, it is especially true that 'delays are dangerous'. As an instance, it may be stated that the chances of a successful issue to a case of lameness in the hip are diminished with every day's delay in commencing suitable treatment.

Below is given a short list of instruments and appliances in common use and of some useful drugs, though it cannot be too strongly impressed that the stock-owner should rather aim at prevention than cure, and that the use of drugs without adequate cause, and an intelligent understanding of their effects, is to be deprecated.

Instruments and Appliances

Clinical thermometer.	Flannel bandages.
Drenching horn.	Lint.
Enema syringe.	Antiseptic wool.
Drawing knife.	Teat syphon.
Tooth rasp.	Probang.
Twitch or 'grin'.	Trocar and canula.
Surgical bandages.	Hoose syringe.

Drugs in Frequent Use

Acetic acid.	Lead acetate.
Alcohol.	Lime.
Aloes.	Linseed meal.
Archangel tar.	Linseed oil.
Areca nut.	Mercurial ointment.
Belladonna extract.	Mercury biniodide.
Belladonna tincture.	Mercury subchloride (calomel).
Bicarbonate of soda.	Nitrate of potash (saltpetre).
Camphorated oil.	Nitrous ether (sweet spirits of nitre).
Cantharides.	Nux vomica powder.
Carbolic acid.	Nux vomica tincture.
Carbonate of ammonia.	Peppermint (oil of).
Castor oil.	Starch.
Caustic potash.	Stavesacre seeds.
Chlorate of potash.	Strong liquor of ammonia.
Chlorodyne.	Sugar of lead (lead acetate).
Common salt.	Sulphate of copper (bluestone).
Demerara sugar.	Sulphate of zinc.
Epsom salts.	Treacle.
Ether (sulphuric).	Turpentine.
Friar's balsam.	
Gentian.	
Ginger.	
Glycerine.	
Iodide of potassium.	
Laudanum (tincture of opium).	

See also separate arts. on specific diseases.

[F. C. M.]

Vice in Animals.—The term 'vice' may be applied to a defect or bad habit in any animal, but is usually restricted in its application to horses. A vice may either mean (1) a bad habit, or (2) an inherent tendency to take harm.

1. A vice is a bad habit; and a bad habit, to constitute vice, must either be shown in the temper of the horse, so as to make him dangerous, or diminish his natural usefulness; or it must be a habit decidedly injurious to his health. Such bad habits as backing, gibbing or setting, biting and savaging, kicking, not lying down, &c., are all vices. Crib-biting is a vice if it has not produced disease; if accompanied by wind sucking it will constitute unsoundness. Besides such bad habits there are various diseases, defects, or alterations in structure, which constitute *unsoundness*. See Unsoundness.

The sale of horses is governed by the same rules as apply to other moveable property (see under Sale). Consequently, there is no implied warranty of freedom from vice, but the question of soundness and vice is almost invariably made the subject of an express warranty. Unless such precaution is taken, the rule of law is *caveat emptor*; that is to say, a buyer who has seen and examined the goods must be held to have approved of them, and, unless fraud on the part of a seller be proved, cannot afterwards reject them on the ground of alleged fault.

2. In the case of the carriage of animals, a carrier is not liable for any loss or damage done which has been caused by the inherent vice or tendency to take harm under ordinary circumstances, and without negligence on the part of the carrier—of the animal carried. See also under Warranty. [D. B.]

Village Industries.—A great deal of what has been written about village industries is not according to knowledge of rural life. The name 'village industries' stands for two separate things. There are, first, industries which have survived or industries which have arisen of themselves; there are, second, industries which have been introduced by philanthropists. A great deal of sentiment is wasted on some vanished village industries. Many of them were more picturesque than sanitary. Most of them have disappeared for the common good. No one believes that the substitution of machinery for hand work has been an unalloyed benefit, but it has helped the world forward. Village industries did not go under because they did not turn out an excellent class of goods. In many cases they did. But, as civilization developed, men found that they had to pay more for these articles, that is, work longer in order to get the wherewithal to buy them, than they were justified in doing. Those who conducted the village industries might be good workmen, but they were poor men of business. And so the home-made article has gone down before the machine-made. No one now pretends that it is better to buy home-made pins and needles than machine-made. Had some rural craftsmen kept step with the times, however, their industries might have survived in the rural districts, for the industries could have been as well, if not more efficiently, carried on in the country as in the towns. But the rural craftsmen lacked enterprise. It was largely due to a want of education and knowledge of the world, which people living in towns were more in the way of getting than they were. In some cases a rural industry has held its own. Take the business of building. The country builder who knows his business and has had an education, is in sufficiently close touch with modern demands and modern facilities for doing work quickly and in keeping with the requirements of modern life, as to be able to undertake jobs which, as to price and manner of execution, compare favourably with what town builders could do in the country. It is of the greatest importance to the countryside that as many industries shall be retained in the rural districts as possible. But they can only be retained on their merits. Village industries which are not efficient had much better go. The spread of primary and secondary education must do something to put the village workman in the way of holding his own with town rivals. It is more education, of the right sort, of which the rural districts stand in need, if they are to have a full development. There are parts of England where education has done very little. At present many villages offer no opportunities to a self-respecting young man who wants to better himself and to make a mark in his trade. And so he is compelled to go to a town. The hope for village industries in the future is threefold. First, there is evidence of a desire on many sides to make rural education a very different thing from the wretched imitation it is now in many districts. Second, the increasing use of the country by townspeople for residential purposes, and the increasing use of machinery in agriculture and in domestic life in the country, make more work for men with trades. Third, there is the growing desire on the part of manufacturing firms to take industries into the country, the facilities offered by railway development and motor traction inviting them to do so. Large city firms are steadily taking their works out into the country. At first the establishment of a manufactory in a village may have an adverse effect on the supply and the cost of labour to the surrounding farmers. But if the new departure is wisely made the manufactory may prove a means of anchoring labour to the district, of maintaining the supply, and, indirectly, of raising the standard of intelligence. If the free open-air and the ever-changing work of the fields with the stock do not offer greater attractions to a suitable number of young fellows than more or less monotonous work within four walls in a village factory, surely the fault is largely that of agriculturists. Either their methods or the teaching which they allow to be given in the local school and elsewhere is at fault. Most country residents know of cases where rural life has been brightened and made more prosperous by the judicious starting of small factories. If the conditions of work at the factories are not what they should be, it is the fault of the localities. Turning now to village industries carried on, not in factories, but in cottages, most of us

know of districts where basket making, for example, is successful. The baskets are needed for the local marketing of fruit. Where there are woods in a district there are often local industries. But to try to introduce into a district an industry for which there is no natural opening is a hopeless proceeding. Up and down the kingdom a great deal of philanthropic effort has been expended in this direction to small purpose. A coddled industry has a demoralizing side. Some industries are merely palliatives of low wages It is not additional work that is wanted, but better or more regular pay for what is done. Nor are village industries wanted for the manufacture of goods at low prices by the labour of children who ought to be learning, playing, or sleeping. There must be many villages where there are openings for well-considered industries, now that motor lorries and vans are dependable and inexpensive, many things might just as well be made in the villages as in the neighbouring towns; but the introduction of the industries calls for wisdom and patience. As to village industries which are more of a recreative and educational than a commercial character, here, again, there are opportunities for doing almost as much harm as good. It is good to make a beautiful thing, but if it is a thing made to be sold, it will be none the less beautiful because it is made primarily in relation to the purpose for which it is intended to be used, and the price that can be paid for it by the person who is to employ it as a tool in work at which he is working for a profit Nothing is sadder in many villages than to notice how, in many boys and girls, the natural skill of their fingers lacks opportunities of expression and development There is a stick carved by a shepherd known to the present writer which proclaims the workman a man with a hidden talent of rare value. Many arts and crafts efforts in villages have been the means of discovering great ability in execution and sometimes in design Apart from the value of the work produced, there is the advantage to the worker from the development of his faculty When a room is opened in a village for arts and crafts, it is necessary that the teaching shall be suggestive rather than precise The great thing is for those who attend to use their own wits. A certain architect, much concerned for the revival in his village of many of the arts of building now no longer practised there, opened a room for the local lads Two who attended were not noticeably devoting themselves to lead glazing, metal work, carpentry or smithing, but still they were evidently working very keenly at something Eventually the founder of the little school was invited down to the village pond, and the two lads surprised him by launching a model steamship which did several knots an hour. Neither had ever seen a ship or the sea! It must also be remembered that though lectures and books may fail of attracting a certain class of village youth, working at making something of their own may be made the means of teaching the value of good work for its own sake, and of inculcating some elementary virtues which, because rural education has been hitherto so much on the wrong lines, urgently need preaching. Hitherto in the rural districts the development has been far too much of a commercial character. To make money is not, however, the object of life. 'Man shall not live by bread alone', and the life of the villages will never be wholesome till this truth is fully realized Without a greater recognition of the place of mental development in rural life, existence there must be as banal as, through the neglect of the fine building traditions which were once observed in the villages, much of their domestic architecture has already become; and the flight to the towns from the dullness and dreariness of it all will go on. ['H C.']

Ville, Georges, a French chemist and vegetable physiologist, was born at Pont-Saint-Esprit, Gard, in 1824 He first studied pharmacy, and then became associated with Boussingault at the Conservatoire des Arts et Métiers, Paris, devoting himself to the pursuit of agricultural chemistry. In 1850 he was appointed professor of agricultural chemistry at the newly-founded Institut National Agronomique at Versailles, and on the suppression of this institution in 1852 he became professor of vegetable physiology at the museum of the Jardin des Plantes at Paris In connection with this museum were experimental fields at Vincennes, and here Ville occupied himself until his death, on February 22, 1897, at the age of seventy-two. Ville is best known in agriculture for the theory which he propounded of the 'dominant' element of fertility He held that for each plant there was a 'dominant' element, and that so long as the requirements of the plant were satisfied in regard to this, it was able to get the remainder of its nourishment from the soil Thus, he showed that nitrogen was the 'dominant' element for wheat, grass, and mangels; phosphoric acid for swedes, and so on To demonstrate this, he introduced a series of trial plots, making the plant, as it were, analyse the soil, and showing the necessity of keeping the land supplied with those constituents which were most readily taken out by crops He placed great value upon lime, especially as gypsum, and showed generally that all the elements of plant food could be derived most cheaply from mineral sources. But he scoffed at the idea of keeping cattle for the purpose of making manure, and denied that organic matter acquired any special virtue by passing it through animals. On the other hand, he spoke well of the ploughing-in of green crops as a means of enriching the soil by the fixing of atmospheric nitrogen. From 1849 to 1852 he worked at the fixation of nitrogen by plants, and, in opposition to Lawes and Gilbert, maintained that plants possessed this power He made determinations of the nitrogen in air, and carried out researches on the assimilation of urea by plants. Ville's principal published works were: (*a*) Les engrais chimiques (3 vols.); (*b*) La production végétale et les engrais chimiques; (*c*) Les engrais chimiques (Conférences de Bruxelles); (*d*) Le propriétaire devant sa ferme délaissée; (*e*) L'école des engrais chimiques. Two of these were translated into English by Sir Wm. Crookes, and published by Longmans & Co. under the

titles (*a*) Artificial Manures, (*b*) The Perplexed Farmer, How is he to meet Alien Competition?

[J. A. V.]

Vine.—In its classical sense the term 'vine' is only used in connection with the grape vine. Therefore to the genus Vitis, nat. ord. Ampelideæ, the title really belongs. Of the hundreds of species of Vitis known to science, the vast majority have no economic value. Many are extremely interesting and beautiful garden plants. Amongst the hardier are the well-known Virginian Creeper, *Vitis hederacea* (*Ampelopsis quinquefolia*), and its Japanese congener, *Vitis inconstans* (*Ampelopsis Veitchii*), whose foliage colours so brilliantly in the autumn.

The most valuable of all the species is, however, the grape vine (*Vitis vinifera*), a plant native to the warm-temperate regions bordering the Mediterranean. It is extremely variable in character, and within certain limits readily adapts itself to its situation and environment. Consequently it has evolved varieties extremely diversified both in foliage and in fruit. Thus, for example, are the varieties from which such valuable commodities as the seedless 'currants' and 'sultanas' to the rich Malaga and Muscatel raisins, all of which are but sun-dried grapes. Then again, from the juices are the various brands of wines, each differing in colour, body, and flavour according to the peculiarities of the variety, district, or particular method of treatment, produced.

The counterpart to the European vine—*V. vinifera*—is the American species *V. Labrusca*, a plant which, though better suited to its native country than the Eastern species, has not attained any degree of popularity either for eating or wine producing. This may be owing to the berries and bunches being much smaller, as well as to the peculiar sweet foxy flavour of the several varieties. The plant has, however, a very valuable quality in its hardiness and vigour of growth. When the French vineyards were threatened with destruction in the seventh decade of last century through the attacks of the vine louse (*Phylloxera vastatrix*), the American vine proved practically immune from the pest, since when it has been successfully employed as a stock whereon to graft the finer and more tender European varieties. This fact has induced hybridists to cross the two species, by which a variety possessing the best qualities of both parents will be evolved. With a plant like the vine, full of latent potentialities, there seems no reason why the desired end should not be attained.

Broadly speaking, the vine is not fastidious as to soil. It will not, however, succeed either in hungry sand or peat, nor in cold water-logged clays. In a deep free loam, containing a good percentage of lime, naturally well drained, the plant will luxuriate. In its growing season it demands a considerable quantity of moisture at the root and will stand a moderate amount of rain, but once the grapes start their last swelling prior to ripening, a heavy rainfall is ruinous. The warm dry climatic conditions of the countries where the vine grows naturally, indicate clearly the requirements of the plant.

In the British Isles, though the plant is hardy in many parts, the climate is too cold and moist as a rule for the successful cultivation of vines out-of-doors as fruit-producing subjects. In the southern counties of England, vines growing against walls are occasionally seen bearing fruit. These isolated cases, however interesting, do not prove that the vine can produce fruit either in quantity or quality to make its cultivation out-of-doors a commercial success.

The immense quantity of grapes now consumed in this country is due to several causes. The rapid means of transit bring good sound outdoor-grown fruit from France, Spain, and Portugal, also of late years from the Cape. These, however good and cheap in their way, cannot compare with the home-grown grapes cultivated under glass. Though grapes were grown in hothouses—such as they were—for many generations, it was the removal of the duty on glass which gave the impetus to the cultivation of exotic plants and fruits, and no garden of any pretension was considered complete without its vinery.

The high prices obtained for grapes of a superior quality, especially late-keeping sorts, induced several shrewd gardeners to embark on their cultivation commercially. The success attained caused others to follow, with the result that at the present day the cultivation of the vine under glass is a very important industry in this country, and excellent grapes are practically within the reach of the poorest, if not as a food at least as a cheap delicacy for invalids.

The change in production has brought about a great change in the class of varieties cultivated. Fifty years ago the small-berried high-flavoured sorts were in favour, and some were met with in every garden along with the Black Hambro, which is still the best grape in cultivation. Nowadays the small-berried Muscadines and Frontignans are rarely seen even in private places, their place being taken by showy large-berried sorts with indifferent flavour which please the eye but not the palate. For early work Foster's Seedling, a sweetish-flavoured green-skinned variety, and the Black Hambro are mostly cultivated. The latter is also the best midseason variety. For later work the Muscat of Alexandria has no compeer; it is by far the richest of the white grapes, and can be kept good for months. In late blacks the Alicante is still favoured, though it has little merit beyond size of bunch, berry, and colour. Gros Maroc is also favoured by some cultivators, but its quality is only second-rate. Gros Colman is a grape which has enhanced its early reputation, simply owing to its requirements being better understood. When introduced it was said to require cool treatment, whereas the very reverse is the case. Under the cool regime it was earthy in flavour, and so watery in the flesh that it would not keep any time in a satisfactory condition; but when grown in the same temperature as the Muscat of Alexandria its whole character was changed, and its large showy berries with moderately firm flesh and refreshing taste have made it one of the most popular market grapes for late use. The latest

of all, and undoubtedly the best keeper meantime, is Lady Downe's Seedling, a black variety with hard flesh and brisk flavour. Like the Gros Colman it is also the better of a high temperature to grow and finish well. It improves by keeping, and is at its best between January and May. It can be kept good until June. There are many new varieties in cultivation said to possess special merits Several undoubtedly do, but they have the demerit of unreliability, and no market grower will risk these so long as standard varieties meet the public demand

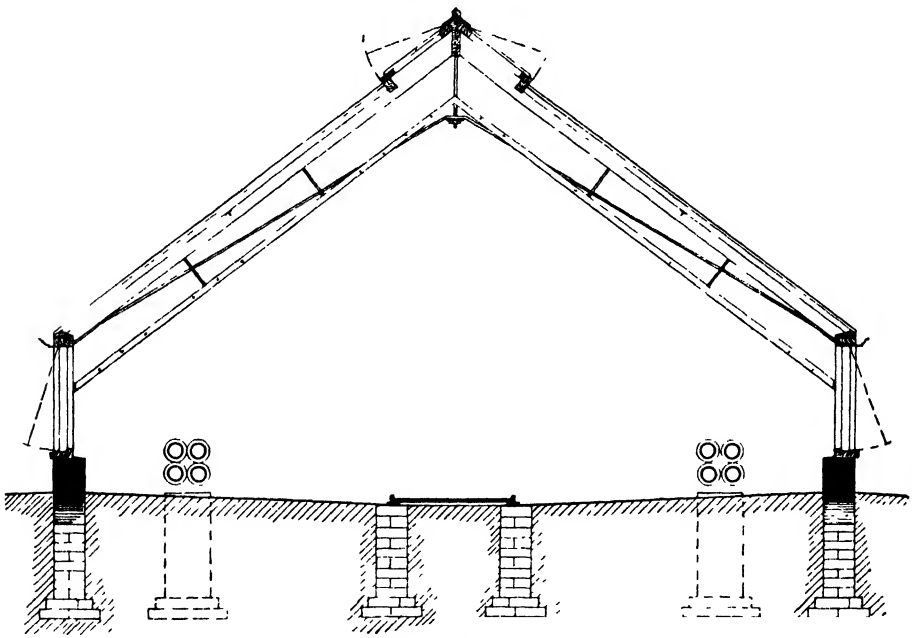
[J. Wh.]

Vine.—Parasitic Fungi. See Grape Vine—Parasitic Fungi.

Vinegar is an aqueous solution of acetic acid, containing about 5 per cent of the acid, and small quantities of colouring and flavouring matters derived from the material from which it was made. If wine be exposed to air, it turns sour owing to the formation of vinegar by oxidation of the alcohol—a change brought about by a ferment, *Mycoderma aceti*. White vinegar is made in vine-growing districts from the poorer qualities of wine. Malt vinegar (brown) is made by the acetic fermentation of 'malt wort', produced in the same manner as for the manufacture of beer. 'Acetates', *i.e.* salts of acetic acid, are found in small amount in certain plant juices, and in the perspiration, milk, muscles, and excrementa of animals. Vinegar readily curdles milk by precipitating the casein—not, however, in a state suitable for cheesemaking

[H. H. G.]

Vinery.—The structure in which vines are to be cultivated need not be an elaborate erection Simplicity of construction ought to be the primary rule. In private establishments



Section of Vinery (span-roof)

the erection and equipment of all plant houses is much more costly than is actually required, but that is due to the desire to have the houses more substantial and ornate in appearance as befitting the situation—matters which have little or no consideration with the commercial grower. The private grower usually builds his fruit houses as half-span or lean-to, a system which has advantages where early forcing is practised. For a lean-to vinery any width between 10 ft. and 16 ft. has in practice been found the most serviceable. In most private establishments, as appearance counts for much, the vinery usually has the end and front walls of stone or brick 2 ft. 6 in. above ground level, with a framing which carries the front ventilating sashes about 3 ft. from under sill to eaves The roof is divided by rafters 7½ by 2½ in., placed at 5-ft. centres, secured to a wall-plate at top by bolts, and braced to front framing with cast-iron brackets or tie-rods; the top ventilating sash being from 2 ft. to 2 ft 6 in. deep according to the size of the house, worked either with rod-and-lever or wheel-and-quadrant arrangement. What is known as 21-oz glass has almost become the universal standard in this country. The panes are usually cut about 2 ft. long and about 14 in wide, according to the spacing of the astragals and rafters. The market growers adopt simpler methods and standardize their material as much as possible. They rarely erect lean-to houses, preferring the

full span, and dispense with the deep rafter entirely, using a stronger and deeper astragal placed wider apart—usually at 19-in. centres. A common size is 4¼ in. by 1¼ in., cut from a 9-by-3-in. deal and run through the planing machine. Some growers dispense with side framing with glazed ventilators, preferring to fix a plain ventilator in the side wall, which rarely exceeds 3 ft. in height. The roof is stiffened by a purlin run longitudinally about midway up the rafter and supported by simple wood or iron standards—cross tie-rods between the purlin and the apex of roof prevents the roof from spreading. The roof ventilators are set at intervals and simply hinged to the centre ridge piece and worked by balance weights or a rod-and-lever arrangement. The glass is cut in squares of 18 in. In glazing, the panes are bedded in putty and sprigged down, no fore or top puttying being done. The usual width of these houses is 30 ft., and about 15 ft. high in the centre, while the length not infrequently runs from 200 to 300 ft. These houses may not be classed as ornamental, but they are extremely practical and serviceable, and from them produce of the highest class is obtained. [J. Wh.]

Vineyard.—In wine-producing countries the vineyard occupies a position similar to that of the wheat field where grain is the staple product of husbandry. Whether it is due to some latent sense of dim and distant association or not, few things will arouse a lethargic traveller more quickly when journeying through a land where the vine is extensively cultivated than the knowledge that he is amongst the vineyards. Probably the ideal his fancy pictured will be rudely shattered as he surveys the severe-looking unpicturesque patches on the somewhat rocky steep sides of some valley, say that of the Rhine. Still, however, these patches scattered unevenly over the hillsides are vineyards under cultivation, and he is fascinated with the potentialities they possess. Further, if he is at all familiar with the cultivation of soil, he must be impressed with the heavy toil necessary to manure and irrigate such awkwardly placed plots; also of the incessant care and anxiety of the husbandman from the period when the vines start into growth until the grapes are gathered.

As the vine is a plant which detests stagnation either in its atmosphere or its soil, the favoured situations for vineyards are those where the fullest amount of sunshine with a free circulation of air can be obtained, and where the soil is sufficiently deep and porous to permit not only the ready passage of an excess of water, but also the free rambling of the long cord-like roots peculiar to the vine. The plants are usually set in rows 4 to 5 ft. apart and at distances of 3½ ft. in the row, and are trained to a height of about 5 ft. They are annually closely pruned on what is known as the spur system. There are numerous varieties in cultivation, each district favouring the sort which experience has shown as most suitable to the locality. The vintage in ordinary seasons is during the month of September.

At one time vineyards were fairly common in the warmer parts of the southern counties of England, chiefly in connection with royal and monastic establishments, and residences of large landowners. It is recorded that vineyards existed as early as the 8th, and frequent allusions are made regarding their existence as late as the 18th century, as at Arundel Castle, Sussex, in 1763 a good wine resembling Burgundy was produced, while later London remarks that at Waltham Green a gentleman grew vines for thirty years in a common field garden.

Whether the decline of vineyards was due in the first place to the decay of the monasteries when those skilled in their management passed away, and in the troubled times no one being trained to follow them the art was lost, or to the import of foreign wines cheaper in price, and probably superior in quality, the fact remains that the vineyards disappeared and few traces now remain of an ancient industry.

The most notable attempt to revive this interesting industry in this country was the formation of a vineyard by the late Marquis of Bute, who in 1875 planted one 4 ac. in extent at Castle Coch, near Cardiff. The experiment conclusively proved that in favourable situations good wine can be produced from grapes grown out-of-doors in this country in hot seasons, such as that of 1887, but in cold sunless seasons, which unfortunately prevail in this country, the results in a pecuniary sense can never be satisfactory.

Probably much of the success of the Castle Coch experiment was due to the untiring energy and ability of the Marquis's head gardener at Cardiff Castle, Mr. Andrew Pettigrew, whose enthusiasm was as keen as that of his employer. With the death of the Marquis and his servant the interest in the work appears to have come to an end, and though the vineyard still exists its retention is probably due more to sentiment than pecuniary gain. The vines at Castle Coch were planted 3 ft. apart and allowed to grow to a height of 4 ft. The variety cultivated is one of French origin named 'Gamay Noir.'

[J. Wh.]

Viola, a large genus of chiefly hardy perennial herbs (nat. ord. Violaceæ), mostly natives of the northern temperate regions and South America. Some of them, notably the Violet (*V. odorata*) (which see), *V. cornuta*, which resembles a large horned violet, and *V. pedata* (Bird's-foot Violet), are cultivated in the gardens; but gardeners generally employ the name Viola as indicating the Show and Fancy Pansies, and the smaller-flowered bedding Violas, or Tufted Pansies, which are excellent plants for beds either grown alone or in conjunction with Roses and other plants. The special-named varieties are propagated by division or cuttings rooted in early summer under hand-lights in a shady place, but Pansies are more usually treated as annuals and raised from seeds. Show Pansies are divided into three sections—Yellow-grounds, White-grounds, and Selfs. They are more popular in the north and in Scotland than in the south, the climate being more favourable for them. Fancy Pansies are more robust, and flower continuously in deep gritty soil enriched with leaf mould. Seeds are sown in August

or September to provide flowers from May onwards, while a sowing may also be made in March for a later display. The summer seedlings are wintered in frames, being planted out in the beds or borders in March. Bedding Violas are a later development; and while their flowers are not so large and striking as those of the other sorts, they are of a more dwarf and spreading habit, and are more useful for general purposes. The soil should be liberally manured in autumn, and the period of flowering may be prolonged by a topdressing and by picking off the flowers. Violas are liable to be attacked by green fly, and should be sprayed with a solution of soft soap to destroy it [W. W.]

Violet.—Sweet Violets, whose flowers are always welcome, particularly during the winter and spring months, are varieties of *Viola odorata*, which is a native of this country. They will grow almost anywhere, but to ensure a good supply of flowers when it is most needed, good soil and cultivation are required. There is generally one position in the garden where violets thrive, and it is not always easy to find, but as a general rule they succeed best in a north border of light sandy soil; in an east or west border, should the soil be medium loam, or in a south border in soil inclining to heaviness. One of the most important points about the cultivation of violets to obtain plenty of fine large flowers is that the stock of plants should be renewed each year; many gardeners do not seem to be aware that old plants are never satisfactory. Despite the competition of violets from the Riviera and also from Cornwall, where they will flower outdoors in winter, these flowers are cultivated for market in the colder districts in frames. Cuttings formed of the small side-shoots are rooted under glass in spring, or the frames may be filled in the summertime with runners taken from older plants. They should be planted in rich, light soil near the glass, and require an abundance of air, but very little water during the dull days. The frames are cleared in the spring, the plants being divided, the old crowns thrown away, and the younger portions retained to provide fresh stock. Red spider is often troublesome upon violets, and it is best remedied by plenty of moisture, and dustings of lime and soot. There is also a fungoid disease which causes white spots to appear upon the leaves; spraying with dilute Bordeaux mixture is the best cure. Marie Louise, Neapolitan, and Swanley (doubles), and The Czar and Princess of Wales (singles) are very good sorts. [W. W.]

Viper (*Vipera* or *Pelias berus*). See Adder.

Viper's Bugloss (*Echium vulgare*) is a biennial weed-plant belonging to the nat. ord. Boragineæ. It abounds on poor light arable land containing lime. The plant is erect, 1 to 2 ft. high, and covered all over with stiff spreading hairs. The flowers, which appear from June to August, are arranged in one-sided spikes (scorpioid cymes)—red when young, but afterwards bright-blue. Each flower produces four hard 'seeds' (nutlets) of a dark-brown colour. After seeding the whole plant dies, and, easily dislodged from the light soil by the force of the wind, is caught up and carried hither and thither, thus ensuring widespread dispersal of the seeds.

To keep land free from Viper's Bugloss the seedlings should be destroyed by careful cultivation, and any clover sown should be free from the weed. [A. S. M'A.]

Viper's Grass, or **Scorzonera** (*Scorzonera hispanica*), is a hardy perennial Composite plant with milky juice (latex), cultivated for the sake of its root, which has a most agreeable flavour. This root is like a carrot in shape but smaller, black outside and pure-white within. The plant is easily raised from seed sown in April or May on any good soil, in drills 1 ft. apart, and covered to the depth of ½ in. The young plants should be thinned out to 8 in. apart in the rows. Some of the roots are ready for pulling in September, others will come forward for winter and spring use. Proper cooking is very important, no milky juice should escape, and so the roots should be merely washed, not scraped; plenty of salt should be added to the water used for boiling, and the cooking should be continued for a quarter of an hour or longer, until the vegetable becomes soft. [A. S. M'A.]

Virginian Creeper. See Ampelopsis.

Virginian Stock (*Malcomia maritima*, nat. ord. Cruciferæ), a native of Europe, &c., introduced in 1713. One of the prettiest and best of hardy annuals, being dwarf, very floriferous, and quick to bloom, thriving in any soil or locality, and often sowing itself and flowering again in the same season. There are varieties with white, rose, crimson, lilac, and yellow flowers. The seeds are generally sown much too thickly. [W. W.]

Vitriol, Blue. See Sulphate of Copper.

Vitriol, Green. See Sulphate of Iron.

Vitriol, Oil of. See Sulphuric Acid.

Voelcker, Augustus.—Since the days of Liebig no one has done more than Augustus Voelcker to bring the teachings of agricultural chemistry home to the farmer, and to make them part of the daily practice of the farm. While himself a man of wide scientific attainment, and endowed with the power of research, Voelcker was intensely practical, and the great hold that he obtained, both for himself and the science he taught, is due in no small measure to the fact that he possessed a thorough knowledge of the farming of the country, and recognized what its needs were, and how far they could be met by the aid of agricultural chemistry.

No man more happily combined 'Practice with Science', and thus carried out in his life the motto of that great society, the Royal Agricultural Society of England, with which he was associated for so many years as its consulting chemist. In this capacity he not only brought the chemistry of agriculture to the door of the farmer, but, alike as a teacher, and later as a professional chemist, he exercised a great influence in making agricultural chemistry indispensable to the farm and to the commerce of his adopted country. Voelcker was, indeed, the first man to constitute agricultural chemistry a branch of the analytical profession, and among the professional men of the present day who

devote themselves mainly to agricultural chemistry there are but few who do not derive their inspiration originally from him. When he first took up this branch of science the agricultural analyst was practically unknown, now he is to be found in every county of England, and in all our universities and colleges.

Augustus Voelcker was born on September 24, 1822, at Frankfort on the Main, Germany, and was the son of a merchant of that town who died when Augustus was eleven years old. His early education was retarded by much illness, which, however, seemed only to spur him, on recovery, to greater energy, as, after serving an apprenticeship to a pharmacist, he distinguished himself by securing admission to the university; and from that time on, as he often used to say, he 'never cost his mother a penny'. This brought about in him an independence and self-reliance which was shown in his after-career, and which enabled him to triumph over the difficulties so often experienced by those coming from a foreign country. Added to this was a simplicity of life and of character which went far to mould a successful career, and with this was combined a kindliness of heart and generosity of action which made him beloved throughout the agricultural world.

He entered Gottingen University in 1844, and came under the influence of Wohler, who at that time shared with Liebig the honour of being the most distinguished chemist in Germany. He took his Ph.D. in 1846, and then went to Utrecht as assistant to Mulder, working there principally on the albuminoid compounds. F. J. W. Johnston, then chemist to the Highland and Agricultural Society, took him away to Edinburgh in 1847, where he remained until August, 1849, lecturing occasionally meantime for Johnston at Durham. It was thus that he became acquainted with the needs of the farmer, and obtained that practical insight into farming that made him, later on, so useful an exponent of science.

In August, 1849, he moved to Cirencester, becoming professor of chemistry at the newly established Royal Agricultural College. His early years at Cirencester were much occupied in writing, especially for Morton's Cyclopædia. He also wrote papers for the British Association, the Royal Agricultural Society's Journal, and the Journal of the Highland and Agricultural Society of Scotland. In 1855 he was appointed chemist to the Bath and West of England Society, coming thus much into contact with Sir Thomas Acland, and contributing valuable papers to the Society's Journal. His first paper in the Journal of the Royal Agricultural Society of England appeared in 1852, and in 1857 he was appointed to succeed Way as consulting chemist to the Royal Agricultural Society of England. This position he retained for twenty-seven years, until his death in 1884, and each half-yearly issue of the Society's Journal contained one or more contributions from his pen. At Cirencester he strengthened those ties with farming which he had already formed, and his own experiments at the College Farm and on farms in the neighbourhood formed the basis of many of his most valuable papers. He had as colleagues Coleman, Buckman, and Brown, and it was to this brilliant staff that Cirencester owed mainly the success which attended its foundation. Voelcker retained his professorship until 1863, when internal dissensions in the College brought about the simultaneous retirement of himself and his colleagues.

By this time his reputation had extended far beyond Cirencester, and he determined on taking the bold step of coming to London and establishing himself in practice as an analytical and consulting chemist. In this he was very successful, and, while devoting himself principally to the agricultural side of the work, he enjoyed a good general practice, and his advice was largely sought in connection with legal matters, Parliamentary and other enquiries, Royal Commissions, and the like. But, while having a large private practice as a chemist, his chief interest and concern was his work as consulting chemist to the Royal Agricultural Society, and the reports which he presented to the Council, and the many papers he contributed to the Journal, testify to the great work which he did towards securing the purity of feedingstuffs and the good quality of the manures and other materials in regular use on the farm.

He was elected a Fellow of the Royal Society in 1870, the Chemical Society, of which he had become a Fellow in 1849, made him a vice-president, and the esteem in which he was held by practical farmers was shown in his being chosen, in 1875, chairman of the Farmers' Club. He was also one of the founders, and a vice-president, of the Institute of Chemistry. In the year 1877, in conjunction with Lawes, he established the Woburn Experimental Farm of the Royal Agricultural Society, becoming almost at once the director of it and retaining this position until his death.

His contributions to agricultural science were very numerous, and his papers are marked by a clearness of expression and conciseness not generally met with in the case of a foreigner. To the Bath and West of England Journal he contributed, as early as 1855 and 1856, papers which, for their completeness, were, and still are, classical. Such were 'Artificial Manures'; 'The Chemistry of Food', 'Farmyard Manure'; 'Lime, Marl, and Shell Sand'; 'Barren and Fertile Soils'. In his paper on 'Farmyard Manure' he showed not only the composition of the different portions, liquid and solid, but also the changes which manure undergoes on keeping, and the ways in which it works on different soils. The facts and figures set out remain as true to-day as when they were first published. Other classical work which he did was comprised in two papers, 'Chemical Properties of Soils' and 'Clover as a Preparatory Crop for Wheat'. In the former he showed the absorptive properties of soils for ammonia, potash, and soda when applied in different forms, as well as the changes produced in soluble phosphates when put on the land. In the latter he supplied the explanation, from chemical considerations, of what was recognized as 'good practice' by the farmer; and it is significant that in this paper he clearly expressed

his belief, though opposed to the conclusions of Lawes and Gilbert, that leguminous plants did obtain their nitrogen, partly at least, from the atmosphere—a fact established at a later date by Hellriegel. In connection with the Rothamsted experiments he gave an important contribution on the 'Composition of Waters of Land Drainage', showing in this how ammonia salts become converted into nitrates

Voelcker wrote extensively also on the composition, nature, and value of the principal foodstuffs used on the farm, and he was the first to employ practically the microscope as an aid in detecting and indicating adulteration in feeding-materials Of this his paper on 'Pure and Mixed Linseed Cakes' is an example. He was also one of the first to make any scientific contribution to the chemistry of milk, cheese, and other dairy products, while, as early as 1858, he showed the efficacy of lime as a preventive of 'finger-and-toe' in turnips, &c. His care in the conduct of field experiments and his writings on the ways in which these should be carried out, and deductions be formed from them, did a great deal to put this work on a right basis, and to form a model for others to follow

He led, almost to the last, a life of strenuous activity, but in December, 1883, he completely broke down, and, after a year of suffering, died on December 5, 1884, at the age of sixty-two

[J. A. V.]

Voles, common Rodents in the genus Microtus (formerly Arvicola), distinguishable from

Field Vole

mice and rats (Mus) by having a broader head with a blunt muzzle, short ears almost buried in the fur, smaller eyes, a relatively shorter tail covered with closely appressed hair and without scales, and relatively shorter limbs The back teeth show two rows of alternating prism-like markings, while those of mice and rats show three rows of tubercles. In fact, voles are more nearly related to hamsters than to mice. They are all strictly vegetarian. In the art. Arvicolinæ, reference is made to the three common voles in Britain, namely the Water Vole (*Microtus amphibius*), the Field Vole (*Microtus agrestis*), and the Bank Vole (*Microtus* or *Evotomys glareola*); this article is devoted to their practical importance.

(1) The water vole, popularly called the 'water rat', breaks down the banks of mill-dams and the like, barks osiers, and may plunder potato pits; but it is not of great importance. It seems to have only one litter in the year. One of its chief enemies is the weasel, and if weasels were allowed to have free course there would be no trouble from water voles. (2) The field vole voraciously devours every kind of vegetable substance—corn, grass, clover, turnips, potatoes, fruits—everything. It may have four to six litters of four to eight young in the course of the summer, and this multiplication if unchecked may readily lead to a plague. Many vole plagues have occurred in Britain, and the devastation has extended over large tracts of country (3) The bank vole is very like the field vole in its habits, but it is less of a burrower, and commoner in gardens than in the open fields. It destroys roots and bulbs, bark and buds, seeds and roots—everything, and it is as prolific as the other species

Numerous devices have been resorted to in order to cope with vole plagues The use of poison is apt to be dangerous, and often defeats itself by cutting off the enemies of the voles. Inoculation with a virus, which works well for rats, has also been tried Smoking badly infested fields with bisulphide of carbon is effective, but expensive. Considerable success has rewarded the burning of affected grass and heather lands and the active pursuit of the vermin by men with wooden spades, and dogs 'Where plantations of limited extent are attacked, pit-falls, wider at the bottom than at the top, and about 18 in deep, have been found efficacious in trapping many voles' Those that fall in do not usually burrow out, but turn on one another in desperation. It is of great importance that the first signs of a vole plague should be met by vigorous and concerted action Perhaps the most important fact, however, is simply this, that the vole has many natural enemies which keep it in check, and that a destruction of these involves quite artificial conditions Stoats, crows, rooks, and great black-backed gulls are notable vole killers; and if it be objected that these do much harm otherwise, the same cannot be said of weasels, owls, buzzards, kestrels, and the smaller gulls. These should be allowed to live and thrive if a wholesome balance of nature is to be preserved

[I. A. T.]

Volvulus. See art. Twist of Intestine.

W

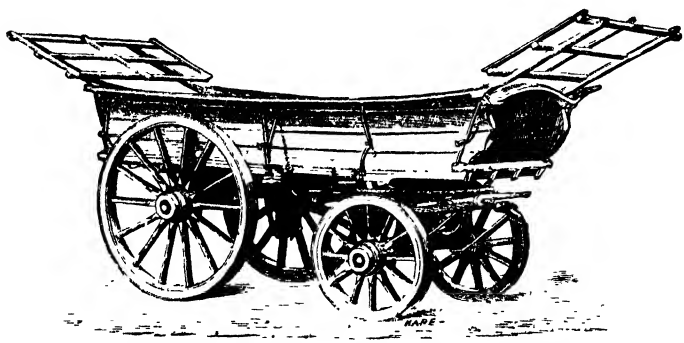
Wages.—The methods of remuneration for agricultural employment that prevail in Great Britain show marked differences according to locality. With certain minor exceptions, it is the custom in Scotland, and in that part of England lying north of the Trent, to engage farm servants, and consequently to fix their wages, by a yearly or more frequently half-yearly agreement. In the south, wages are paid by the week. The practice in Ireland resembles that of the north of Great Britain, except in those districts where the holdings are small, and hired labour correspondingly rare. It follows that in the north wages are fairly regular throughout the year, and are calculated on the basis of a cash payment combined with board in the case of the unmarried men, or certain regular allowances for those who are married, with little or no additional remuneration on special occasions. In the south-east, wages are low, and much time is lost through bad weather, for which no payment is made, while large earnings are often made by piecework, and additional work at harvest, and other occasions. As extreme instances may be quoted, on the one hand, the hinds on a farm in the Glendell Union of Northumberland, who receive a weekly cash wage throughout the year, with no piecework, or extra payment at harvest; and, on the other, two labourers in the Hollingbourne Union of Kent, whose piecework earnings, exclusive of corn harvest, formed 73 and 77 per cent of their total cash earnings.

Real wages therefore approximate much closer throughout the kingdom than cash wages do. But even after making these adjustments, wages vary considerably in different counties, and even in different parts of the same county. This is generally due to the proximity of towns or mines or other centres of industry, where higher wages can be earned. Such counties are Northumberland, Warwickshire, Hertfordshire, Essex, Kent, and Surrey. In purely agricultural counties such as Norfolk and Suffolk, wages are fairly uniform throughout the district. Taking the county as a unit, however, the highest average weekly earnings, including allowances, in England, are paid in Durham (22*s.* 2*d*.), in Wales, in Glamorgan (21*s.* 3*d*.); in Scotland, in Renfrew and Lanark (22*s.* 2*d*.), and in Ireland, in Down (13*s*.). The lowest average weekly earnings in England are paid in Oxfordshire (14*s.* 6*d*.); in Wales, Cardiganshire (15*s.* 8*d*.); in Scotland, in the counties of Caithness and Shetland and Orkney (13*s.* 7*d*.); and in Ireland, in Mayo (8*s.* 9*d*.). These discrepancies are, however, much reduced by the lower cost of living and house rent in the counties where low wages are paid, and in the case of Ireland the total earnings are probably increased by payment for harvest work in England. Such wages are, of course, not paid to all classes of labour alike. Ordinary labourers are paid a lower rate than men in charge of horses or cattle, and these in turn often receive less than shepherds, though the duties of the two latter farm servants are correspondingly longer, more responsible, or more irksome. The variations in such payments, which are made partly in cash and partly in kind, are too numerous and complicated to be discussed here. It will be readily understood that these rates of wages have not stood at their present level for a long period. The general rise in the wages of labour which has taken place in the United Kingdom in recent years has affected agriculture, though not to the same extent as other forms of industry. Nor has the rise been constant or uniform. A comparison of the labour bill on big farms in England and Wales for each year from 1850 to 1903 shows that cash payments, exclusive of extra money for piecework, hay and corn harvest, overtime, &c., as well as of the value of allowances in kind, varied from 9*s.* 2½*d.* in 1851 to 14*s.* 7*d* in 1902-3, and in 125 farms between 1874 and 1903 from 13*s.* 2½*d* in 1887-8 to 14*s.* 11½*d* in 1902-3. Similar figures are not available for Scotland, but the average cash wages on 10 Irish farms between 1850 and 1903 rose from 5*s* 10½*d* in 1850-4 to 10*s* 8*d* in 1903. The rise in Ireland was continuous, and as far as can be ascertained was approximately so in Scotland; but in England and Wales such changes as took place were obviously affected by the periods of prosperity and depression which agriculture underwent in that time. Wages rose with very few exceptions from 1850 to 1877-8, when they reached a temporary maximum of 13*s.* 8*d*., but owing to the heavy losses experienced in the succeeding years, they fell to 12*s* 9½*d.* in 1887-8, from which date they rose steadily till 1903. The rise in recent years has been much more rapid than in the earlier period. This rise too has been accomplished in spite of, perhaps to a certain extent because of, the introduction of expensive agricultural machinery, which, while it avoided the necessity for a large amount of manual labour, made the employment of more highly skilled labour obligatory. The labour referred to above is mainly residential, but every year a large number of persons are brought from the towns or from Ireland into the agricultural districts to supplement local labour. Many of the persons brought from the towns are women and are engaged in very unskilled occupations, but the Irish are mostly men and are employed in harvest work or other heavy tasks. The money thus earned is often high, and must always be taken into account in considering the total yearly sums gained by labourers in Ireland and the amount spent by farmers in Great Britain. The introduction of modern agricultural machinery, however, has caused this immigration to play a less important part in the economy of the farm than was formerly the case. The employment of casual labour from the towns is probably on the increase in accordance with the development of fruit farming.

[A. G. L. R.]

Wagons are four-wheeled vehicles used for

general hauling purposes on the farm, and are distinguished from lorries by having a body with more or less high sides, some taking a box form, and some with lower sides—an intermediate between these types and known as boat or float bodies. Farm wagons generally have no springs, are heavy in construction, weight, and draught. There are exceptions to these, but in many districts longevity appears to be the first

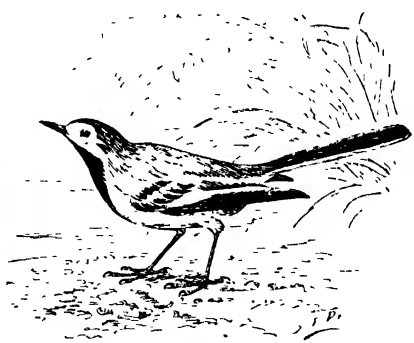


Farm Wagon (Bristol Wagon and Carriage Works Co., Ltd.)

aim, and British wagons are widely different to those met with in America and Canada, where durability is less considered than immediate profitable utility. It is certain that many wagons in use are heavier than present conditions require, since roads have generally been so much improved. When roadways in some heavy land districts were almost impassable, heavy wagons with tires 7 to 9 in. wide were found necessary, and single shafts were required because the deep ruts prevented horses walking abreast. There are counties where the wagons are little altered, presumably because the making has been largely in the hands of local wheelwrights who have adhered closely to the models handed down to them. The wooden axle has not in quite a large proportion given way to the steel. Wagons have been shown to be less economical than carts for ordinary farm purposes, but a wagon is convenient on all farms for some purposes, and since boys as drivers are difficult to obtain, there is a point in the use of wagons in harvesting, especially on hilly ground. Wagons made by firms with considerable experience in building four-wheeled vehicles on modern lines, are far lighter in all respects than ordinary rural-made wagons, whilst there is no loss in strength in the essential parts, and the draught is far easier. The peculiar variations in shape affected by makers in country districts are dispensed with as a rule, consequently uniformity in type is gradually extending throughout the country. Apart from heavy farm wagons, lighter types, with springs, for marketing market-garden and special produce are extensively used by those who cater for special markets. For ordinary farm purposes it is unnecessary to provide for loads of more than 3 tons, and a tire of 4 in. width meets all ordinary requirements. Modern wagons are generally made with a fore-carriage which allows the front wheels to run under the body. Canadian wagons have lighter wheels, and the tires rarely exceed 3 in. to carry a little over 2 tons, and are usually used with a pole in the place of shafts.

[W. J. M.]

Wagtails (Motacilla).- Of five native species of these familiar birds only three are more or less common. (1) The Pied Wagtail (*Motacilla lugubris*) is readily distinguished by its black-and white plumage, and many are resident the whole year, though some migrate during the winter. It haunts meadows and pasture, and builds its nest near water in April, of moss and vegetable fibre lined by hair, wool, and feathers. The four to six eggs are marked with brownish dots on a whitish ground. (2) The Grey Wagtail (*M. melanope*) is particularly characteristic of hilly ground in south-west England, but extends northwards into Scotland. The upper side of the body is grey, and the under side yellow. The nest is built in April in the bank of a stream, and resembles that of the preceding species, but the five eggs are creamy-white with light-brownish spots and sometimes a few dark streaks. (3) The Yellow Wagtail (*M. campestris*) is a migrant species, appearing in April, and



Wagtail

leaving in August or September. Widely distributed through the marshes, pastures, and arable fields of England, it is rare in Ireland and the Scottish Highlands. The prevailing colour of the plumage is yellow, greenish above and bright below. The nest is built in April, usually on the ground, of fine vegetable fibre, lined with hair, wool, and feathers. The eggs resemble those of the last species. All Wagtails feed solely on animal food, chiefly insects, small snails, and slugs. They are distinctly

beneficial to agriculture, and deserve the most rigorous protection, especially as in all probability they devour the small snail (*Limnæa truncatula*) which harbours the early stages in the life of the liver fluke. [J. R. A. D.]

Wales, Agriculture of. — Wales has always been, generally speaking, a pastoral rather than an arable country, and has depended more upon its flocks and herds than on the direct products of its soil. A great part of the country consists of mountain and rough ground, which can only be used as pasture for sheep, and much of it is poor even for that purpose. There are, however, tracts of land of considerable area, which in wheat-growing days were largely arable, and where a considerable amount of corn is produced now. But in the lowlands as well as in the hill districts, the land is mostly under grass, and stock-raising is the chief feature of the country. The following figures, taken from the Agricultural Statistics for 1908 issued by the Board of Agriculture and Fisheries, will show the relative amount of land under grass and tillage in the Principality —

	Acres
Total area of land	4,748,398
Total under permanent grass	2,040,805
Total arable land	746,709
Mountain and heath land used for grazing	1,319,982
Area under woods (1905)	184,361

The general character of the agriculture of the country may be inferred from these figures, over 70 per cent of the total area being under permanent grass, mountain and heath. Excluding mountain and heath, the proportion of land under permanent grass has, as in England, greatly increased during the last thirty years.

The soil of Wales, for the most part, is naturally poor, resting mainly on the rocks of the Cambrian and Silurian systems. The Old Red Sandstone appears in the border counties of South Wales, and on this there is some excellent land. In the larger valleys there is a considerable amount of fertile alluvial soil, but in the smaller valleys the soil is for the most part gravelly. Limestones appear in many districts, and the soil on these, where there is any depth, is often very good. There is in places, also, a considerable amount of peat. The soil varies greatly according to the geological and other conditions; but whilst there is excellent soil in certain districts, what may be described as typical Welsh soil, resting on slate and shale rocks, is of very moderate fertility, its general physical properties being as much responsible for this as its poor chemical composition. This kind of soil usually responds well to applications of lime and of phosphates.

The best parts of Wales for agricultural, as distinct from purely pastoral, purposes, are Anglesey, the Vale of Clwyd, the Valley of the Dee, including the district of Maelor, and the Severn Valley in North Wales, and Pembrokeshire, the Vale of Towy, the Vale of Teify, the Vale of Glamorgan, and the Wye Valley in South Wales. In all these districts there is some excellent land, most of which is under grass, although there is also a considerable area under tillage. There are tracts near the coast and numerous small valleys, which lend themselves to tillage operations to a greater or less extent, and in many of which there is some exceedingly good land for grazing as well as for mixed farming. It may be added that the good soil of Pembrokeshire corresponds to the rich lands of the south of Ireland.

The farms in Wales are, generally speaking, small, over two-thirds of the total number of holdings being under 50 ac. in extent, and considerably less than 1 per cent being over 300 ac. In the hill districts, which constitute the great bulk of the total area of the country, there is generally a sheepwalk on the mountain included in the holding, and affording pasturage for so many sheep. The sheepwalks vary greatly in size, and often extend to many hundreds of acres. Apart from the large sheep farms, which consist chiefly of mountain land, there are relatively very few farms in Wales that may be described as large, in the sense in which this is understood in other parts of Britain. In some districts freeholds are common, but the bulk of the farms are rented. Of the total extent of land under crops and grass in 1908, 89·7 per cent was occupied by tenants, a slightly higher percentage than in either England or Scotland.

It has been shown that the amount of arable land in Wales is relatively small, amounting in 1908 to 746,709 ac., or less than that of the county of Norfolk. Of this, in that year, about three-sevenths was under clover and rotation grasses, a little more than three-sevenths under corn, and the remaining one-seventh was occupied by other crops and bare fallow. Oats are the principal corn crop, the parts of Wales where this crop is mostly grown being the counties of Anglesey, Denbigh, and Montgomery in North Wales, and Cardigan, Carmarthen, and Pembroke in South Wales. It is in Anglesey and Pembrokeshire that the heaviest crops of oats are on the average grown. The chief barley districts are Denbighshire, Cardiganshire, and Pembrokeshire, the last-named having the largest area. The total area under wheat is comparatively small, Montgomeryshire producing most of any Welsh county in 1908. The Vale of Clwyd in North Wales was formerly a great wheat-growing district, much of the land there being specially suitable for this crop. There is a fair area under wheat still in Denbighshire, as well as in Cardiganshire and Carmarthenshire. The area under the three chief corn crops in 1908 and the yield are shown in the following table.—

	Acres	Total Produce in quarters	Average yield per acre in bushels for 10 years 1898–1907
Wheat	34,573	117,010	26·37
Barley	86,693	324,945	31·37
Oats	201,595	864,420	34·69

The average yield per acre is below that for England and Scotland all through. The bulk of the corn produced is used for stock, and it

is only in a few districts that any appreciable quantity is grown for sale. Beans are grown in the Vale of Clwyd and the Severn Valley to a considerable extent, and peas are grown to a slight extent in most of the Welsh counties. Roots are successfully grown in most districts where there is an appreciable amount of arable land, very heavy crops being produced in some districts. Potatoes also are grown in small quantities throughout the country. Roots and potatoes, however, only occupy about one-eighth of the area returned as arable.

The rotation followed in most parts of Wales is a long one, consisting of oats, roots, barley or oats, seeds, the land being left in grass for three, four, or more years. Much of the land is of such a character that it must be ploughed up again after four or five years. Generally speaking, it is kept under grass as long as it will graze satisfactorily, so that the length of the rotation varies to some extent with the district. In some cases the rotation is modified by taking wheat after oats and before roots. There are also other modifications, but the rotation given above is the one adopted on what may be described as typical Welsh farms. Where beans and clover are grown more or less regularly, such as in the Vale of Clwyd in North Wales, the rotation followed is much of the same type as those adopted on heavy land elsewhere. In the Vale of Clwyd, and the districts adjoining, a large amount of red clover is grown for seed. It is from these parts that the 'Welsh clover' of seedsmen mostly comes.

Of the area under permanent grass in Wales a large proportion is annually cut for hay. The land kept for hay includes a large amount of bog, which yields short, dry, and apparently poor hay, on which young store cattle are largely fed in the hill districts during the winter. Where there is only a small area under corn, and but few roots grown, the hay crop is necessarily of more than ordinary importance.

Wales, as already indicated, has always been dependent in a special degree upon its live stock, and of late years much has been done to improve and develop the different classes of stock in the country. The special breeds associated with Wales are described in the articles Kerry Hill Sheep, Ryeland Sheep, Welsh Mountain Sheep, Welsh Black Cattle, and it is not necessary here to deal with that part of the subject further than to observe that the general system of farming in the Principality has been determined largely by the particular character of the native breeds of live stock, which in their turn, no doubt, have been influenced largely by the character of the country.

All classes of stock are more or less extensively bred, but cattle and sheep are the main products of the country. It is chiefly also as a breeding, as distinct from a feeding, country that Wales must be regarded. According to the Agricultural Returns for 1909, the number of cattle in Wales in that year was 744,672, and the total number of sheep was 3,795,342. The system of management and of disposing of the stock varies in different districts, but the chief feature of the cattle-raising industry in Wales is the number of store cattle of different ages that are annually sent into England for feeding. They do not all, however, go to the English counties direct from the breeder. There are graziers in Wales, who buy the cattle from the breeders, and after keeping them for the summer, dispose of them in the autumn, some for winter feeding in root-growing districts at home, but the majority to cross the English border. In typical hill districts the cattle are sold as yearlings as a rule. Throughout Wales there is a large amount of dairy produce made, which consists chiefly of butter, and a relatively large number of cows is kept. The amount of keep available on upland farms is limited, and this renders it necessary to sell as yearlings the cattle that are bred in such cases. There are many exceptions to the rule, but generally speaking it is a combination of dairying and rearing that is found in the upland districts, and of dairying and grazing in the more fertile districts. In some localities the summer feeding of cattle is carried on to a considerable extent, but taking the country as a whole, the amount of first-rate pasture land is small. A good deal of winter feeding is carried on in most districts where there is a fair proportion of tillage land. This, however, is governed largely by the state of the store-cattle trade.

With the exception of the mining centres of South Wales, there are few thickly populated districts in the Principality. Around these centres, in the quarry districts of North Wales, and in the neighbourhood of seaside towns, there has of late years been a great increase in the amount of milk produced, and milk-selling has developed greatly in Wales as in other parts of the kingdom. Buttermaking has always been carried on extensively in most parts of the country, and cheesemaking is now carried on in some districts, notably in Denbighshire and Flintshire, where large quantities of excellent Cheshire cheese are manufactured, and in the Caerphilly cheese districts of South Wales. In South Wales a number of co-operative dairies have recently been established.

Sheep-breeding is, in the typical upland districts, of far greater importance than any other branch of farming. The tendency in favour of younger mutton, and the enormous development in the production of fat lambs, have brought about in recent years a considerable modification in the general system of management of hill flocks, which, however, need not be discussed here. Sheep are scarcely less important in many lowland districts, where wethers are largely fed in the winter, and large numbers of lambs are bred for the market. While the live stock is more mixed in the lowland than it is in the hill districts, sheep-breeding on an extensive scale is carried on throughout the country.

Horse-breeding is confined to certain districts, amongst which Montgomeryshire has perhaps the highest reputation, especially as regards heavy horses. Welsh ponies, the breeding of which is by no means an unimportant feature of the country, are chiefly bred in mid-Wales. A great deal of enterprise has of late years been

shown in connection with the breeding of Shire horses, particularly in those parts of Wales that are adapted for the breeding of that class of stock; and the establishment of the Welsh Pony and Cob Society has done much also for the classes in which the Society is specially interested. Efforts have lately been made to encourage the breeding of hunters, which have not hitherto been bred in Wales to any extent

In the better agricultural districts of Wales the general methods of cultivation are much what they are in similar districts in other parts of Britain. Artificial manures, chiefly phosphatic, are largely used, and the implements and machinery are of modern design Grass being always of chief importance, much improvement has taken place of late years in the selection of grass and clover seeds, and in the methods of laying down land to pasture Much more attention is now also paid to new varieties of cereals, roots, and potatoes

In the upland districts, agricultural operations are of a more simple character, and the system generally is more primitive Artificial manures are used only to a slight extent, and modern implements for cleaning and thoroughly working the land are rare This is largely due to the small area of land under cultivation in typical hill districts

Provision for agricultural education is made by the University Colleges at Aberystwyth and Bangor, at each of which there is a department of agriculture, and various courses are arranged for farmers' sons and other students. All the Welsh counties devote a certain amount of money annually to educational work in agriculture, which in the majority of cases is conducted by the colleges. Agriculture is taught also in some of the intermediate schools, and several counties have taken steps to adapt the elementary education in the direction of rural pursuits

Agriculturally, Wales is seriously handicapped by the large area of comparatively useless land within its boundary, and also by its wet climate, which renders the country unsuitable for the most part for arable farming. Along the sea coast, however, while the rainfall is relatively heavy, and high winds are common, it is in many places extremely mild This is especially true of the southern coast line, where vines may be successfully grown in the open The natural conditions are such as to make Wales, as a whole, specially adapted for stock-raising, and upon this branch of husbandry its prosperity chiefly depends. [C. B. J.]

Wallflower (Cheiranthus), a genus of hardy and half-hardy annual, biennial, and perennial herbs, widely distributed, which in addition to *C. Cheiri*, the progenitor of the most popular garden wallflowers, contains some pretty and fragrant Alpine species (*C alpinus*, 1 ft., yellow flowers, and others), well adapted for a place in the border or the rockery *C. kewensis* (*Cheiri mutabilis*), which has purple and brown flowers, is an excellent long-blooming winter greenhouse plant. There are a large number of excellent variously coloured named varieties of the deliciously fragrant early-spring and summer flowering common wallflower The single-flowered sorts are more hardy than the double kinds, which are well adapted for making a display in the greenhouse in spring. It is well to sow the seeds earlier than it is often done, as if well-ripened growth is not made before winter comes the show of flowers will be poor. Seeds may be sown as early as May or June in a sunny position, but the soil need not be rich Transplant the seedlings when 2 in high into rows 6 in. apart, and later on transfer these again to roomier quarters, leaving, if desired, some of the plants behind to flower where they are After the summer bedding has been cleared away, wallflowers make very ornamental winter occupants of the beds. *C. Cheiri* is a true perennial when grown on a light soil in a sunny position. Wallflowers are best suited by a light soil. [W. W.]

Walnut (Juglans) is a genus of the nat ord. Juglandaceæ, to which also the Hickory (Carya) belongs (see HICKORY) There are ten species of Walnut, three of which belong to Europe, Africa, and Asia, and seven to America, and in addition there are many varieties By far the most important of these is the Common Walnut (*Juglans regia*), indigenous throughout the south of Europe, and extending eastwards along the Himalayas to Sikkim and Upper Burma, although two North American species, the Black Walnut (*J. nigra*) and the Grey Walnut or Butternut (*J cinerea*), are hardy and of rapid growth in Europe The Juglandaceæ are trees, rarely shrubs, characterized by having alternate, pinnate, and often aromatic leaves, monœcious flowers, the male being in lateral pendulous catkins, with 2 or more anthers, nearly sessile, inserted on the upper surface of a bract bearing on its edge 2 to 6 membranous perianth-lobes, and the female being either in few-flowered erect and terminal or many-flowered lateral spikes, with perianth adnate to the 1-celled ovary, 1 ovule, erect, fruit a 2-valved nut or drupe In the genus Juglans the female flowers are terminal, solitary or 2 to 3, and the bracts are not enlarged in the fruit, which is a drupe with leathery pericarp and woody endocarp. The Common Walnut (*J. regia*) is a large deciduous aromatic tree, with young shoots tomentose In its leafless winter condition the twigs bear a strong resemblance to those of the Ash, but differ in having alternate greenish buds (not opposite and black as in Ash). The imparipinnate leaves have 5 to 13 leaflets, subsessile, opposite or nearly so, and usually entire (those of seedlings serrate) The male catkins are on the previous year's wood above the leaf-scars, 2 to 5 in. long, 5 to 6 perianth-lobes, and 10 to 20 anthers; while the female flowers are sessile, terminal, indistinctly 4-toothed, and green, with usually minute petals. The very aromatic green fruit, about 2 in. long, has a leathery pericarp enclosing an irregularly furrowed and more or less thick-shelled light-brown nut divided by two thin coriaceous dissepiments into 4 incomplete cells, one dissepiment separating the 2 cotyledons, and the other dividing them into 2 lobes. The cotyledons remain underground when germinating. The Common Walnut is a common British tree growing to about

60 ft. high and 7 to 12 ft. in girth. On old stems the thick grey bark is deeply furrowed with vertical parallel fissures, while the bark on the branches remains smooth and light-grey. Though chiefly cultivated for its fruit, the wood of big old trees is valuable for furniture, and it is the best wood for gun-stocks. The broad greyish-white sapwood soon gets worm-eaten, but the even-grained, moderately hard, greyish-brown heartwood, with darker streaks and often beautifully mottled, is durable. Its average weight is about 44 lb per cubic foot. In Southern Europe, where Walnut trees attain an age of 300 to 400 years, the timber is largely used for furniture and carving, and in America it is one of the chief ornamental woods, the supply of which is now becoming scarce. In Southern Europe supplies of 'burred' timber are insufficient, and imports are made from Kashmir into France. Walnut is a light-demanding tree, which thrives best on a deep, light, humose soil, and the chief damage it suffers is from late frost in May, while its foliage is being flushed. It is best to grow Walnut from imported nuts, and to sow them as soon as convenient after they ripen in October, as otherwise the germinative power soon decreases. The seedlings throw out strong tap-roots, and should be transplanted into the nursery lines when one year old. The Black Walnut is hardier than the common species, and gives fine timber, the growing of which in California is said to hold out a good prospect of being very remunerative. It also grows well in the warmest and driest parts of England. [J. N.]

1 Branch of Walnut. *a*, Male flowers, *b b*, female flowers. 2, Female flower. 3, Male flower. 4, Section of Walnut. *c*, Seed, *d*, green husk, *e e*, shell.

Warble Flies, or **Œstridæ,** are a family of diptera or two-winged flies which live in their larval stage as parasites in warm-blooded animals and man. Some of the best known are the Ox Warbles or Bots (*Hypoderma lineatum* and *H. bovis*); the Sheep Nasal Fly (*Œstrus ovis*); the Horse Bots (*Gastrophilus equi*, *G. nasalis*, and *G. hæmorrhoidalis*); the Deer Bot (*Cephenomyia rufibarbis*), all of which are common in Britain, and also *Hypoderma diana* and *Pharyngomyia picta* in deer. Abroad, man is subject to the attack of 'bots'; the 'macaw' worm, 'torcel' or 'ura' is well known, and is called *Dermatobia noxialis*. It occurs from Mexico to Brazil. The Dermatobia also attack animals, and now and then the Hypoderma of cattle attack man. The larvæ or bots live under the skin (Hypoderma and Dermatobia), in the head (Œstrus), and in the alimentary canal (Gastrophilus), and others in the pharyngeal cavities (Cephenomyia). The adult flies have rudimentary mouth parts. They are all day fliers and take but little food, and all have a great aversion to water and cold air. The Warble Flies are only found on the wing during the hottest part of the year and day. Some, such as the Horse Bot Flies and the Ox Warble Flies, lay their eggs in the hair, others, such as the Sheep Nasal Fly, deposit not eggs but young maggots or bots on the nostrils of the sheep. The 'bots' are all more or less spiny in their later stages, and as in all diptera or two-winged flies they are footless. They have two breathing pores at the end of their body, and the mouth parts consist of two hook-like structures, the mandibles. On completing the maggot or 'bot' stage the Œstrids leave their host and fall to the ground, where they work their way under stones, tufts of grass, &c., and become puparia.

The Warble or Bot Flies are mostly hairy flies resembling worker bees, thick-set and with large heads, but some are almost nude, as the Sheep Nasal Fly. The chief character is the large head, which is much swollen below, and the comparatively small and bare eyes.

[F. V. T.]

Warbler. See Garden Warbler.

Warbles. See art. Bots.

Warington, Robert, is probably best known to the student of agriculture through the excellent and almost unique handbook, Chemistry of the Farm, which he contributed

to the Books of the Farm Series (Vinton & Co.), and which attained such success that, during his lifetime, it reached the 19th edition, being several times revised by him and brought up to date. Of it, it may be said that it is a model of what such a book should be. While retaining its small compass, it is literally 'packed' with sound information set out in concentrated form and with scientific method.

Warington was born in London on August 22, 1838, being himself the son of parents known on both sides for their scientific attainments His father was one of the founders of the Chemical Society, and secretary of it for ten years. The son unfortunately suffered from bad health, and his boyhood was clouded over through this, so that he was unable to associate with others of his own age or to engage in outdoor pursuits This undoubtedly told on his nature, and led to his often not being fully understood, and to his work not being justly appreciated He was essentially a man who worked best alone, and was unsuited as a colleague His collaboration with Lawes and Gilbert, though it resulted in the publication of some notable researches, could not be described as a happy one, and jealousies were frequent Warington was a laborious and careful investigator, yet he was not a man of great originality. What, however, he was eminently successful in, was in taking up a line of work which some other investigator had started on, and in following it out In this way, by much laborious work, he carried to a successful issue chemical and analytical processes, as well as problems of agricultural research, which had been initiated by others Nevertheless, to him is due the classical work on nitrification, with which his name will be always associated Even in this he was denied the reward of seeing his work carried to its fullest natural conclusion, for, though he obtained cultures which converted ammonia into nitrites, and others which converted nitrites into nitrates, and thus showed that nitrification was the work of two different organisms, it was left to Schloesing and Muntz to isolate the organisms themselves, which Winogradski subsequently got out in bodily form

Warington, after working in his father's laboratory at the Apothecaries' Hall, went first to Rothamsted for a year in 1859. After this he became assistant to Edward Frankland at South Kensington, and, going in 1869 to the Royal Agricultural College, Cirencester, remained there four and a half years as assistant, first to Augustus Voelcker, and subsequently to A. H. Church. While here he worked at the estimation of phosphoric acid, and on the influence of ferric and aluminic salts in soils in the decomposition of soluble phosphate and the formation of ferric phosphate. He also did ash analyses of whole bodies of oxen, sheep, and pigs for the Rothamsted Experiments.

Leaving Cirencester in the year 1867, he became chemist to Lawes's citric and tartaric acid works, Millwall, staying there until 1876, and publishing papers relative to these acids. Eighteen years later he returned to these works, and tackled the then serious question of the presence of lead in commercial citric and tartaric acids. All his other work was on agricultural chemistry.

In 1876, at Lawes's invitation, he returned to Rothamsted, and associated himself with the work there, publishing papers, both alone and in collaboration with Lawes and Gilbert While here he improved the methods for determination of nitrogen and carbon, and perfected several methods of analysis connected with agricultural research.

His own particular work, that on nitrification, began in 1877, and went on to 1891, the results being contained in ten papers contributed to the Journal of the Chemical Society It was he who showed how nitrification proceeded, and the conditions under which it throve, this culminating in his demonstrating that two different organisms were concerned in the work of nitrification.

On parting from Lawes and Gilbert, Warington went to America to lecture for the Lawes Agricultural Trust, and in 1894 he was elected Sibthorpian Professor of Rural Economy at Oxford University, which post he held for three years Thereafter he retired into private life, busying himself with writing, and in local and, chiefly, religious works His health, which had never been good, gave way altogether in 1906, and he died on March 20, 1907 He was elected a Fellow of the Chemical Society in 1863, and subsequently became a Vice-President He was also made a Fellow of the Royal Society in 1886.

[J. A. V.]

Warm-blooded Animals. - Mammals and Birds are the only warm-blooded animals The term refers not so much to the fact that the body temperature is *high*, but to the fact that it remains practically *constant*. In cold-blooded animals (such as reptiles, amphibians, and fishes) it changes as the external temperature changes —not necessarily so much, but proportionately The contrast of warm-blooded and cold-blooded is expressed technically in the terms *stenothermal* (of constant temperature) or *homoiothermal* (of uniform temperature), and *poikilothermal* (of changeable temperature) A few illustrations may be given of the temperatures in warm-blooded animals Man, 36° to 38° C.; dog, about 39°; sheep, about 40°, rabbit, 31° to 32°; cow, 39·5°, fowl, 41° to 42°; ducks, 42·1°. Even in healthy warm-blooded animals the temperature varies a little with times and seasons; it is higher in young animals than in old ones; it may be higher in one sex than in the other; it is increased by feeding and exercise In fowls it has been observed that the temperature rises in excitement and falls during incubation and in hypnosis.

The heat of the body is produced by chemical changes in the living tissue It is produced especially in the muscles, but also in glands, in the brain, indeed everywhere. The muscles produce most, and they can do so apart from work production, for instance in sleep. The heat is lost by radiation and in the evaporation of sweat, and the secret of warm-blooded animals is to maintain an equilibrium between heat production and heat loss. This is effected by a regulating nervous mechanism, which in a very complex way can alter both production

and loss of heat, adjusting them to one another. This 'thermotaxic mechanism' is not fully at work in very young birds and mammals; it ceases to act in hibernating mammals when the temperature falls below a certain point; it is deranged in fever.

It is interesting to find that the lowest mammals—the Monotremes—are very imperfectly warm-blooded. The average temperature for many Echidnas was 29·4°; but one cold morning 22° was registered in one individual; another in fierce heat (and carried in a sack) registered 36·6°—an extraordinary range for a mammal. Even in Marsupials, which come next in the Mammalian series, there is sometimes considerable range of temperature variation. Thus in the Koala, with an average of 36°, variations from 34·9° to 38·4° were observed in a healthy animal. The average for Marsupials is some 3° less than the average of higher Mammals. Thus both as regards temperature and its degree of uniformity there is a gentle gradation from the cold-blooded Reptiles, through Monotremes and Marsupials, to the typical Mammals. It has been recently observed that camels taken from India to Australia show striking oscillations in temperature, as much as 5° C. in a day. [J. A. T.]

Warp and Warping.—Warp is a deposit of silt laid down, chiefly at river estuaries, through the agency of a system of artificial irrigation or by natural flooding. In the districts of the Humber and its tributaries, the practice of warping is extensively followed in the reclamation and improvement of low-lying swamps, by means of which these wastes have been converted into arable land of high fertility. The method adopted consists essentially in diverting the mud-charged waters of these rivers, when they become dammed back by tidal currents, and leading them over the ground to be ameliorated. Here, by embankments and sluices, the waters are confined within a definite area until they have deposited their burden of silt; they are then run off, and the process is repeated as often as may be found necessary. Warping is obviously possible only when the lands in the neighbourhood of the rivers are below the level of high tide or flood.

In Egypt the periodic inundations of the Nile similarly enrich the level tracts along the river. In the process of time these accumulations have converted arid land into one of the most fertile regions of the world.

The soil produced by warping has all the characteristics of fine alluvium. [T. H.]

Warranty.—A warranty is a guarantee, express or implied, given by the seller to a purchaser of land or goods, but the subject is here treated with reference to goods only as opposed to heritage. Warranty as regards England and Ireland means an agreement with reference to goods which are the subject of a contract of sale, but collateral to the main purpose of such contract, the breach of which gives rise to a claim for damages, but not to a right to reject the goods and treat the contract as repudiated. As regards Scotland, a breach of warranty is deemed to be a failure to perform a material part of the contract. (Sale of Goods Act, 1893, sec. 62.)

In a contract of sale, unless the circumstances of the contract are such as to show a different intention, there is: (1) An implied condition on the part of the seller that he has the right to sell the goods; (2) an implied warranty that the buyer shall have quiet possession of the goods; (3) an implied warranty that the goods shall be free from any incumbrance in favour of a third party not made known to the buyer when the contract is made.

There is, however, no implied warranty as to the quality or fitness of goods except under the conditions referred to in the article on SALE (which see). Subject to the exceptions above referred to, the maxim of law is *caveat emptor*; that is to say, a buyer who has seen and examined goods must be held to have approved them, and unless fraud on the part of the seller be proved, cannot afterwards reject them on the ground of alleged fault.

The question of warranty arises very frequently with regard to the sale of animals and especially of horses. As the sale of horses is governed by the same rules as apply to other moveable property, there is no implied warranty of soundness, and a purchaser should always ask for an express warranty. An express warranty may be either verbal or written, and every affirmation at the time of sale is held to be a warranty provided it appears to have been so intended. But every statement made by a seller anxious to make a sale will not amount to an express warranty, and such boastful recommendations as are commonly made with a view to effecting a sale do not necessarily amount to a warranty, and must be taken with the proverbial grain of salt. Consequently, a prudent purchaser will always insist on an express warranty in writing. See art. SALE. [D. B.]

Warren.—Rabbits are gregarious animals, and a large number of their burrows are usually found in close proximity to each other, forming what is known as a rabbit warren. These warrens are to be found in widely different situations, for the rabbit is an adaptable creature and will flourish in very varied environments. The holes are sometimes excavated in open fields, sometimes in woods, and occasionally they can be seen high up on the face of a sandy cliff. But perhaps the type of country most favoured (or most infested) by the rodents is open sandy downs, where there is plenty of grass for them to feed upon, and a sufficiency of cover in the shape of gorse, &c.

Shooting over a natural rabbit warren often provides excellent sport; but for the sportsman to whom a plenitude of targets makes a special appeal, nothing is so good as an artificial warren. Such a one can be easily created even in an apparently unsuitable spot. A field is selected close to a wood in which the quadrupeds are known to dwell, and the meadow is then fenced around with rabbit-proof fencing, apertures large enough for the animals to pass through being left at intervals. Iron doors are fitted to the openings so that they can be closed at will. Food and artificial cover are provided for them within the enclosure, and after a few months immense numbers will have grown accustomed

to availing themselves of the opportunity. One night all the doors are closed, and on the next day there will be a prodigious expenditure of cartridges. [H. S. R. E.]

Warts (Verrucæ) cause disfigurement and often great annoyance to animals, according to their size, situation, and variety. They are composed for the most part of piled-up epithelium, but encysted fibro-fatty tumours under the skin are commonly called warts by stockmen, and require simple remedial measures We may conveniently divide warts into the pedunculated, or such as have a neck, the broad-based, and the encysted. The first variety offer very little difficulty, as they are easily strangulated by waxed ends or other ligatures of unyielding material, and of a thickness suited to the particular wart to be got rid of. The broad-based must usually be disposed of by solvents, of which we have a choice For such as are situated upon the belly or limbs we may employ 1 part of arsenic mixed with 2 parts of soft soap, taking care not to injure the skin around, and not to drop portions which fowls may pick up For warts about the eyes and mouth, and upon the teats of cows, we must be content to use milder applications, such as 1 part by measure of salicylic acid to 8 parts of collodion, painting on this mixture rapidly day by day, and about the fourth day picking off the scab to facilitate the solvent's action. The large masses often called angleberries should be taken hold of boldly and twisted off with force; the tearing away favours the arrest of haemorrhage afterwards the arsenical soap may be applied [H L]

Washing of Sheep. See Sheep Washing

Wasp. See Vespa.

Wasp Beetle, a black wasp-like beetle. See Clytus arietis.

Waste Land Planting, like woodland planting of any other description, can only be successful where there is a favourable combination of the following five factors: (1) Suitable soil and situation, with such soil preparation as may be necessary; (2) suitable kinds of trees, and of a suitable size and quality; (3) a suitable method and distance of planting; (4) adequate protection against weeds, human actions, live stock, game and vermin for some years, till the young plantation has thoroughly established itself; and (5) immunity from serious damage by late frosts, drought, fire, insects, fungus disease, &c.

1. Soil preparation is essentially required on very wet land, which must be more or less thoroughly drained before it can be considered in a fit condition for planting; and the drainage should be done well in advance of the planting (see art. Drainage of Woodland Soil). Where the surface soil is shallow and resting on stiff till or moorpan, this has to be broken through by trenching or subsoil ploughing in strips; and where the soil covering is of such a nature (bracken, furze) as to be likely to choke the young plants, this has first to be cut and its growth checked by burning over the area—except where, as is also usual on heather land, it is best to retain the heather to give shelter against late frost, wind, and spring drought, because the protection thus afforded is most valuable for the thriving of the young plantation.

2. The most suitable kinds of trees are usually conifers on most classes of dry land, with softwoods (Alder, Birch, Willow, Poplar) and also Spruce and *Thuja gigantea* on low-lying and moist lands. Where waste lands are suitable for broad-leaved trees the soil is usually quite good enough for being reclaimed and used agriculturally. Among conifers Spruce is, in general, on the whole the most suitable kind for shallow and moist soil, and Scots Pine for a dry tract, while Larch does best on land having good natural drainage, Douglas Fir in sheltered situations, and Silver Fir on a deep and somewhat heavy soil *Thuja gigantea* and *Cupressus macrocarpa* also do well in many parts of the west of Scotland (*e.g.* Garlatter and Benmore, in Argyllshire) The best class of 2-year-2 transplants is needed (except with *C. macrocarpa*), and it is of far more importance that the plants should be bushy and sturdy, with well-developed fibrous roots, than that they should be bigger than from 15 to 18 in. for Spruce, Pine, or Silver Fir, or 18 to 24 in for Larch, Douglas Fir, &c

3. If the soil be dry and poor, and particularly if notching be the planting method adopted, the plants may have to be set at 3½ or 3 ft apart, but otherwise 4 by 4 ft (2722 per acre) is about the average number required in order to get the young plantation to close up well before the tenth year. Unless there be a good local market for early thinnings, close planting may be far more of a drawback than an advantage Notching is only suitable for a very light soil, and even then it should usually be found more profitable in the long run to adopt pit-planting with a **C**-shaped or an **S**-shaped conical spade on all suitable soil, the cheapest and simplest form of pitting (see Planting). And the growth of weeds close to the plants can be kept down by previously inverting a good big sod, and either notching or boring through it with the spade, while lifting the sods from a continuous line on a wet hillside also helps to drain the land (*e.g.* as at Corrour, in Inverness-shire).

4. Weeding is usually necessary for at least two years after planting land previously grazed over, because the grasses, &c, come up very strong after the cattle and sheep are removed. And if there have been some softwoods on the area previously, their stool-shoots and suckers will come up so strongly as often to occasion a good deal of expense in preventing them from doing harm. In such cases it is usually best not to remove the trees till the young plants have fairly established themselves.

5. The chief dangers to which young plantations on waste lands are exposed are late frosts, weeds, and game (especially black cock, rabbits, and hares). [J. N.]

Water. — Of all substances occurring in nature, none transcends water in abundance or importance. In the liquid form it covers four-fifths of the surface of the globe, and constitutes a similar proportion of the total mass of animal and vegetable matter. In the form of vapour it occurs in enormous quantities in

the atmosphere, and in the solid form, as snow or ice, abounds in the colder regions of mountains and around the Poles. It is the universal medium in which the life processes of plants and animals are carried on, as well as most of the chemical changes that occur in nature. It exercises an incalculable influence upon climate, and in other ways has throughout the ages been a determining factor in the history of the world.

As met with in nature, water is never pure, but always contains dissolved impurities arising from materials with which it has been in contact. So great and universal indeed is the solvent action of water, that the preparation of absolutely pure water is almost impossible, although the degree of impurity may be reduced to an infinitesimal quantity without great difficulty by a carefully conducted process of distillation. In the pure state, water is a chemical combination of the two elements oxygen and hydrogen, in the proportion of 8 parts by weight of the former to 1 of the latter. It changes into the solid form (ice or snow) when cooled to 0° C. (= 32° F.), and into the state of vapour at temperatures above this, the rate of vaporization being dependent upon the temperature and also upon the pressure of the atmosphere—as recorded by the barometer—upon the surface of the water. The higher the temperature or the lower the barometric pressure, the greater is the tendency of the water to pass into vapour or steam. When water exposed to the average barometric pressure of 76 cm. (= 29·9 in.) is heated, its temperature rises until it reaches 100° C. (= 212° F.), at which point it remains stationary whilst the water boils, *i.e.* is converted rapidly into steam, bubbles of which are formed throughout the entire mass of the liquid. This 'boiling point' varies according to the atmospheric pressure upon the surface of the water, being higher the greater the pressure. Thus, for this reason, water boils at a lower temperature at the summit of a mountain than at its base, and indeed, at very high levels, the tendency to evaporation may be so great as to constitute a serious practical problem in connection with the storage of water.

The conversion of ice into ice-cold water and of boiling water into steam is accompanied by the absorption of large quantities of heat, which are stored up in the water and steam respectively, and given out again when the steam is condensed or the cold water frozen. This 'latent heat', as it is called, is a factor of great importance in the economy of nature. Thus the yielding up of the latent heat in the formation of ice tends to mitigate somewhat the rigours of the winter frost, whilst the intensity of the summer heat is similarly tempered by the great absorption of heat in the increased evaporation of water to which it gives rise. The proverbial mildness of island climates in comparison with those of continental areas of similar latitude finds a ready explanation in these facts. Water thus, by virtue of its latent heats of solidification and vaporization, exercises a great moderating influence upon climate. It also, in similar fashion, exercises a great influence upon the temperatures of soils, the heat required to evaporate the water from the soil being withdrawn largely from the soil particles themselves and the soil thereby kept cool.

Water is further characterized among liquids by its great storage capacity for heat, the amount of heat required to raise the temperature of unit weight of water by 1 degree (its 'specific heat') being far greater than that required by an equal weight of any other liquid for the same purpose. In other words, water can store up large amounts of heat without its temperature rising very considerably, that is to say, water (and therefore wet material such as soil) heats up slowly and cools down slowly. The moderating influence of water upon climate referred to above, is still further enhanced by this characteristic, since the ocean during the summer warms up so slowly that its temperature always lags appreciably behind that of the land, upon which it exercises, therefore, a cooling influence. During its slow cooling in the colder parts of the year, on the other hand, it gives up enormous quantities of heat, which appreciably reduce the rate of cooling of the atmosphere over wide areas adjoining.

A further, almost unique property of water is its increase in bulk in the act of freezing. When water at the ordinary temperature is cooled down it gradually shrinks in volume (*i.e.* becomes more dense) until the temperature of 4° C. (= 39·2° F.) is reached. It then commences to increase in bulk, slowly at first, and when 0° C. (= 32° F.) is reached, the formation of ice occurs and is accompanied by a considerable expansion, amounting to about one-eleventh of the bulk of the water. In the case of other liquids, almost without exception, the act of solidification is accompanied by shrinkage, and hence the solid produced is denser than the liquid and sinks. Were water not exceptional in this respect, the accumulation of ice at the bottom of lakes, &c., would so affect the climate over large tracts of the earth's surface as to enormously reduce the habitable area of the globe. In actual fact, however, ice being less dense than water remains at the surface, and hence is readily melted when thaw conditions set in.

The expansion of water in freezing further plays an important part in the mechanical breaking down of rocks into soil, the expansive force exerted by the freezing water in the crevices and pores of rocks being an exceedingly powerful disintegrating agency. An idea of the pressures that may be exercised under these conditions is conveyed by the observation that in order to lower the freezing point of water by 1° C. it must be subjected to a pressure of 136 atmospheres.

The fact above mentioned, that water reaches its maximum density at a temperature above its freezing point also has consequences of the highest importance in nature, since it ensures that no ice can form upon the surface of a sheet of water until the temperature of the whole mass has been reduced to this point (4° C.). Thus, when the temperature of the atmosphere falls to 0° C. the surface water of, say, a pond in contact with it is cooled, contracts, thereby

becoming denser, and sinks, whilst lighter and warmer water rises to supply its place. This in turn cools, sinks, and is replaced by warmer water; and this circulation continues until the temperature of the whole mass of water has been reduced to 4° C. After this point has been attained the surface water will no longer sink, however much it be cooled, since it is now always lighter than the deeper water at 4°. Further cooling of the deeper layers can now only take place by the process of conduction from particle to particle, which is exceedingly slow in the case of water. Hence the crust of ice grows in thickness only very slowly, and the bulk of the water remains in liquid form at 4° C.—a temperature not unsuited to the continued existence of fishes and other aquatic animals and plants.

Reference has already been made to the great solvent powers of water, and these must be kept in mind in dealing with natural waters, which we may now proceed to consider.

Natural waters have their origin, directly or indirectly, in the atmospheric moisture, which reaches the ground in the form of rain, snow, &c. Rain is thus obviously the purest natural water, other waters approximating the more closely to it, the less the rain from which they are derived has been in contact with rocks or other sources of contamination. This is well illustrated by the following data:—

	Total Dissolved Solids
	Parts per 100,000
Unpolluted rainwater (39 samples)	2 95
Surface water (rivers and lakes) (195 samples)	9 67
Spring waters (198 samples)	28 20
Deep-well waters (157 samples)	43 78

Even rain, however, is not pure, but always contains traces of impurities, such as ammonia and other nitrogenous matters, chlorides, and sulphates. Rain falling in or near towns may indeed contain relatively large amounts of these impurities, together with suspended matters and free acid arising from smoke. The following data are instructive upon this point —

YEARLY AVERAGE PROPORTIONS OF IMPURITIES IN TOWN AND COUNTRY RAIN

(Parts per million)

		Total Suspended Matters	Total Sulphur expressed as SO_3	Total Chlorine	Nitrogen present as Ammonia	Nitrogen present as Nitrate	Free Acid expressed as Sulphuric Acid (H_2SO_4)
[1] Leeds—Industrial area	*a*	280 0	38 54	35 43	2 79	0	16 12
	b	337 7	23 60	29 30	2 32	0	6 28
,, Suburban	*a*	26 22	17·45	6 16	1 45	0 19	2 03
	b	16 10	13 18	6 72	1 04	0 12	0
[2] Country rain (Rothamsted)		,,	2 57	2 28	0 44	0 18	0?

[1] Crowther and Ruston, British Association, Sheffield Meeting, 1910
[2] Miller, Journ Agric Science, vol 1 p 280

After reaching the surface of the earth the rain acquires further impurities owing to its solvent action upon rocks and other materials with which it comes into contact. The more prolonged this contact, and the more soluble the ingredients of the rocks, &c., the greater will be the contamination suffered by the water. Its history during this stage may be extremely varied. Thus the rain may fall in uninhabited districts on unmanured soil, or it may fall on soil impregnated with manurial residues; it may largely run off the surface into the streams, or it may percolate through greatly varying depths of soil and rock and emerge in springs or wells; it may come into contact only with difficultly soluble materials such as granite, or with the relatively easily dissolved chalk. From these considerations it will be clear that great differences in character are found in natural waters. Indeed their value for domestic or trade purposes is largely determined by the nature and amount of the impurities contained in them.

Before dealing with the classification and merits of different types of natural waters, it is necessary to give some explanation of the kind of information that is sought for in the examination of waters with a view to obtaining evidence as to their suitability for drinking or other purposes.

Valuation of Water Supplies.—The utmost importance is attached to a knowledge of the *source* and *history* of the water, these being in many cases such as to enable a reliable opinion to be arrived at without resort to analysis.

The *colour*, *taste*, and *smell* of the water, especially after storage in a closed bottle, may also furnish useful supplementary information.

In the great majority of cases, however, no reliable estimate of the value of a water can be based simply upon an examination of its history and outward characteristics, but it is necessary to supplement the knowledge obtained of these by a more or less extended analysis of carefully procured samples. For the purpose of sampling, a glass-stoppered bottle of at least half a gallon capacity should be used. This should be thoroughly cleaned, rinsed repeatedly with the water to be sampled, then completely filled, securely stoppered, sealed, and forwarded to the analyst without delay.

The nature of the analysis made with the sample will be very much simpler if the water is required merely for steam-raising or washing purposes than if intended for drinking or dairy purposes.

Valuation of Water intended only for Technical Purposes.—In the former case the analysis may usually be limited to estimations of the *total solids* (*suspended and dissolved*), *acidity*, and *hardness* of the water. For the bearing of these factors upon the value of the water see art. WATER SUPPLY. Only the last-named needs further explanation at this point.

The term 'hardness' as applied to waters is based upon the relative ease or otherwise with which they will form a fairly permanent lather with soap. Waters which form such a lather only with difficulty and at relatively great expenditure of soap are termed 'hard' in contradistinction to such as lather easily, which are termed 'soft'. The property of hardness arises from the presence in dissolved form in the water of substances (usually sulphates, chlorides, and bicarbonates of lime and magnesia) which interact with the soap, forming insoluble substances which separate out as a scum upon the surface of the water. Hardness due to the presence of bicarbonates can be removed by boiling the water or by the addition of slaked lime, and is termed *temporary hardness*, as distinguished from the hardness arising from the presence of sulphates and chlorides, which is termed *permanent hardness* since it is unaffected by the above measures. It is customary to express the hardness of a water as if it were entirely due to carbonate of lime in the water, and to state the proportion of this either in parts per 100,000 or grains per gallon (= parts per 70,000), these figures being also referred to sometimes as 'degrees' of hardness. A water is commonly described as 'hard' if it shows more than 10 degrees of hardness (parts per 100,000).

Valuation of Water intended for Drinking or Dairy Purposes.—The analysis of water that is intended for drinking purposes includes the estimations referred to above, but less importance is generally attached to them than in the case of waters intended for technical purposes.

Far greater importance is attached to the determination of the *nature and amount of any organic* (i.e. *animal or vegetable*) *matter* present in the water. This will have its origin in vegetable or animal matters with which the water has come into contact at some stage of its course. Organic matter of vegetable origin (from peat, &c.) is commonly regarded as practically harmless and negligible, except in so far as it imparts a brown tint to the water and renders it uninviting in appearance and unpalatable. The presence of organic matter of animal origin, on the other hand, is regarded with the very gravest suspicion, owing to the possibility of the contaminating animal matters being of the nature of animal excrements, which may be infested with the germs of dangerous diseases. Many epidemics, notably of Asiatic cholera and typhoid fever, have been disseminated by waters polluted in this fashion, and it is in this direction that the danger chiefly lies. The solid excrements of animals are always infested with myriads of bacteria, including some types which are known to produce a tendency to diarrhœa and similar intestinal disturbances when introduced into the human digestive tract. In addition, the excrements form a favourable medium for the propagation of many of the most dangerous disease-producing organisms, which retain their vitality when washed out by water. There is thus something far more important than sentiment involved in the objection to waters that are polluted even to the slightest extent with impurities of animal origin.

The estimation of the amount and character of the organic matter in a water is beset with the greatest difficulties, and in practice can only be effected indirectly. The most direct method is that introduced by Frankland, in which the solids contained in the water are isolated and their content of *organic carbon* and of *organic nitrogen* determined. The amount of organic carbon may be taken as a measure of the total amount of organic matter, whilst the ratio of nitrogen to carbon will often furnish a clue as to whether the organic matter is of vegetable or of animal origin, since the latter form is usually much more nitrogenous in character than the former. Thus, a water polluted with sewage will usually be found to contain suspiciously large amounts of both carbon and nitrogen in organic forms, whereas a water contaminated with peat or other vegetable matter will contain but little organic nitrogen as compared with its content of organic carbon. Further investigation of the water is necessary, however, before the conclusion arrived at upon these lines can be accepted as reliable, since the original polluting matter will have undergone to some extent a bacterial fermentation (see below), the tendency of which is to make animal matters less and vegetable matters more nitrogenous. Hence, if the pollution has occurred some considerable time before the sample of water is taken and analysed, the organic matter, even if of animal origin, may have been reduced by this fermentation to a residue relatively poor in nitrogen.

In polluted waters freely exposed to the air the nitrogen of the organic matter is more or less rapidly converted by bacterial agency into ammonia, which then undergoes further bacterial fermentation, with the production first of nitrites and then of nitrates (see art. NITRIFICATION). Other bacteria may, under suitable conditions, attack some of the nitrate thus produced and reconvert it into ammonia, or by liberating nitrogen in gaseous form cause some of it to be removed from the water.

For these reasons it is customary in the analysis of drinking waters to include estimations of the *ammonia* (free and combined) and *nitrates* (including nitrites) present. These ingredients in themselves do not necessarily impair the wholesomeness of drinking water, but it is clear, from the explanation just given of their origin, that they furnish evidence of the highest importance as to what the previous history of the water has been. Thus, if the organic nitrogen be high, whilst ammonia and nitrates are very low, the contamination is obviously of very recent origin; whereas if nitrates abound and ammonia is low, the source of pollution must be looked for at a much earlier stage in the water's history.

Further evidence as to the character of the organic pollution may often be obtained from the proportion of *chlorine* present (as chlorides, *e.g* common salt) in the water. An estimation of this ingredient is therefore usually included. Animal matter is usually much richer in chlorine than vegetable matter, urine (human), for example, containing usually about 500 parts of chlorine (equivalent to 824 parts of common salt) per 100,000 In interpreting the chlorine results, however, the greatest caution must be used, in view of the widespread occurrence of common salt in many strata of the earth's crust. A high chlorine content can only be regarded as of importance as an indication of pollution by matters of animal origin when it coincides with other indications of such pollution.

Another estimation that is commonly included in water analysis, with a view to obtaining guidance as to the amount and nature of the organic matter present, is that first introduced by Wanklyn, based upon the amount of ammonia evolved when the water is boiled with an alkaline solution of permanganate of potash. This *albuminoid ammonia* is regarded as a measure of the nitrogenous organic matter, and is more freely yielded by animal matters than by those of vegetable origin The results may therefore be interpreted in similar fashion to those obtained for the organic nitrogen referred to above.

A third method of indirectly measuring the extent of contamination with organic matter is based upon the extent to which the water can decolorize a solution of permanganate of potash The change that takes place consists essentially in a removal of oxygen from the permanganate, and hence the results are commonly expressed as the *oxygen absorption* of the water. The amount of oxygen absorbed is regarded as roughly proportional to the amount of organic matter present, but it furnishes no guidance as to whether this organic matter is animal or vegetable in character.

When the results obtained in the analytical processes outlined above are considered in conjunction with the information otherwise obtained as to the source and history of the water, it is usually possible to form a reliable opinion as to whether or not the water has at any time suffered appreciable contamination by matters of animal origin. Chemical analysis alone, however, cannot reveal whether the contamination will be actively detrimental to the health of consumers of the water or not. On this point it can only arouse suspicions, but for the positive evidence recourse must be had to a *bacteriological analysis* of the water. The bacteriologist, by methods which cannot be summarized here, enumerates and classifies the different living micro-organisms present in the water, devoting special care to the isolation and identification of particular organisms that are known to be characteristic of certain modes of contamination, or that are specific causes of disease. The number and nature of the bacteria found to be present then decide whether the water is to be condemned outright or not. If a chemical analysis alone be made, then the only safe procedure is to condemn all waters that show signs of appreciable pollution from animal sources.

Having now explained the nature and significance of the various criteria of purity commonly adopted in the analysis of waters, we may proceed to consider the classification and characteristics of different natural waters. (See table on p. 87.)

Classification and Characteristics of Natural Waters.—Natural waters may be grouped under the following heads:-

1. Rain-water (including dew, snow, hail, and hoar frost).
2. Upland surface waters
3. Surface water from cultivated land.
4. Shallow-well waters
5. Deep-well waters
6. Fresh spring waters
7. Mineral spring waters.
8. Sea water

Waters used for drinking or industrial purposes are derived from classes 1–6 Data illustrative of the composition of such waters are given on p. 87, and will serve to illustrate the discussion of the characteristics of the different types of water, to which we may now pass.

Rain-water has already been referred to, and little further need be said at this point We have seen that rain falling in districts remote from human habitations is not absolutely pure water, but the proportion of impurity present in it is exceedingly small Dew and hoar frost are always less pure than rain falling in the same locality, since they are derived exclusively from the lowest and most contaminated layers of the atmosphere

Upland surface waters (*i.e.* surface waters in mountainous or other uncultivated and practically uninhabited districts) rank in purity next to the rain from which they originate The amount and nature of the ingredients dissolved in them are determined mainly by the character of the soil and vegetation with which they have come into contact From the examples given on p 87 it will be seen that they do not contain any considerable amount of dissolved solids unless the strata over or through which they pass are fairly rich in carbonate of lime (chalk or limestone). They are hardly liable to be contaminated with animal matters, but may contain appreciable quantities of organic matter of vegetable origin (peat, &c). They are hence remarkably free from ammonia, nitrates and nitrites, and chlorides are also low Any contamination with animal matter will usually therefore be clearly revealed in the proportions of these ingredients If the water be derived from peaty areas it will usually have a brown tint.

Surface water from cultivated land varies enormously in character according to the season of the year and to the extent, character, and manuring of the land over and through which the water has passed This class includes, moreover, the great body of river waters, many of which become polluted in other ways. The essential difference between waters of this class and upland surface waters lies in their higher content of dissolved solids, owing to their more

AVERAGE COMPOSITION OF NATURAL WATERS

(Abridged from Sixth Report of Rivers Pollution Commission, 1874)

Parts per 100,000

Geological Formation of Rocks	No. of Samples	Total Solids	Organic Carbon.	Organic Nitrogen	Nitrogen present as Ammonia	Nitrogen present as Nitrate and Nitrite.	Total Nitrogen	Chlorine.	Hardness		
									Temporary	Permanent	Total
Upland Surface Waters from Non-calcareous Strata											
Igneous Rocks	18	5·15	·278	·033	·001	·002	·035	1·13	·1	2 0	2·1
Cambrian, Silurian, and Devonian	81	5·12	293	·024	·002	·006	031	·92	·3	2 5	2·8
Yoredale and Millstone Grits, and Non-calcareous Portion of Coal Measures	47	8·75	·377	033	·003	010	·050	1·05	·4	4·3	4 7
Lower London Tertiaries and Bagshot Beds	3	8 40	·379	048	004	007	·058	2 06	3	3 5	3 8
Upland Surface Waters from Calcareous Strata											
Silurian and Devonian	3	13 71	300	026	0	021	·047	1·20	1 2	7·4	8 6
Mountain Limestone	7	17 07	370	047	·001	·011	·059	1 24	5 7	7·0	12·7
Calcareous Coal Measures	26	22 79	·346	·037	·003	016	056	1 52	4 0	8 3	12·3
Lias and New Red Sandstone	8	18 92	·300	042	002	·012	056	1 50	7 8	6·3	14 1
Surface Waters from Cultivated Land											
(a) *from non-calcareous districts*	31	9 52	·276	034	007	·089	·128	1·49	·6	4 3	4·9
(b) *from calcareous districts*	141	30 08	268	053	005	277	·314	2·21	12 1	8·2	20 6
Shallow-well Waters											
Devonian max	29	105 20	794	172	630	1 197	4 261	17 00	18 3	47·8	55 7
Devonian min		12 16	004	003	0	033	039	1·60	0	3 2	5·0
Coal Measures max	44	220 92	1 200	169	170	10 102	10 262	29 00	28 2	112 6	140 8
Coal Measures min		9 40	021	·007	0	0	015	99	0	1 4	3 4
New Red Sandstone max	87	240 20	2 349	316	620	14 717	15 333	39 00	52 0	99 6	127 1
New Red Sandstone min		20 64	029	009	0	0	027	1 40	0	3 8	17·1
Chalk max	33	159 16	772	340	1 700	6 345	7 779	28 50	39 7	47 1	71 5
Chalk min.		32·48	014	007	0	613	628	1 79	12 0	5 6	23 6
Deep-well Waters											
Devonian	5	29 41	017	012	0	400	412	2 96	8 9	9 4	18 3
Coal Measures	9	83 10	·119	·034	044	207	278	18 05	15 1	20 6	35 7
New Red Sandstone	28	30 63	·036	011	003	717	·734	2 94	7 4	10 5	17·9
Chalk	66	36 88	050	017	001	·610	628	2 76	21 2	6 5	27 7
Fresh Spring Waters											
Granite and Gneiss	8	5·94	012	·008	001	106	115	1 69	·4	2·6	3·0
Silurian	15	12 33	·051	014	001	178	192	1 84	1 5	5 3	6 8
Devonian and Old Red Sandstone	22	25 06	·054	·012	·001	764	777	3·85	4 8	7 2	12 0
New Red Sandstone	15	28 69	·065	017	·001	330	349	2·19	8 1	10 7	18 8
Mountain Limestone	13	32·06	087	·010	001	169	181	1 73	6·6	5 7	12 3
Chalk	30	29·84	044	·010	·001	382	392	2 45	18·1	5·5	23 6
Oolites	35	30 33	·043	·011	001	402	·414	1·55	18 2	6·2	24·4
Coal Measures	22	21·91	050	·014	·001	393	·408	1·85	5·2	7 9	13·1
Lower and Upper Greensand	19	30 05	·053	012	0	·326	·338	2 98	13 6	6 6	20 2

intimate and prolonged contact with soil and rocks of different kind. Of greater practical importance than this, however, is their greater liability to pollution with animal matters, owing to the proximity of the cultivated land to farms and human habitations, and the use of animal excrements for manurial purposes. The amount of dissolved matters present varies greatly according to the history of the water, being highest in the case of waters from calcareous districts. Thus, the water of the Thames, which is derived largely from a chalk area, contains usually (at Battersea) about 30 parts of dissolved solids per 100,000 as compared with less than 6 parts per 100,000 in the water of the Dee, which is fed mainly from older strata, chiefly slate and sandstone, which are very poor in carbonate of lime. For information upon the effect of soil upon the composition of the water that passes through it, see art. Drainage Water.

Shallow-well waters are of the utmost practical importance, since a large proportion of the population is still dependent upon supplies of this class for domestic purposes. For discussion of

their value in this respect see art. WATER SUPPLY. Such waters, having been subjected to more or less prolonged and intimate contact with the soil and rocks through which they have percolated, are naturally in general richer in dissolved matters than surface waters. They may contain appreciable quantities of nitrates, but unless polluted, should be practically free from ammonia and organic nitrogen.

Deep-well waters and *spring waters* are very similar in character. By a 'deep' well must be understood one which is sunk through an impervious stratum to a porous water-bearing stratum in which the water is held up by an impervious stratum underlying it (see also ARTESIAN WELLS). Such waters must therefore have undergone a very thorough filtration in their percolation through considerable depths of rock. This is shown by their extraordinary freedom from organic matter or suspended matter of any kind. In many cases they are extremely 'hard', however, especially if derived from calcareous strata. Thus, spring waters from magnesian limestone will commonly contain more than ten times the proportion of dissolved solids that is usually found in those emanating from granitic rock, and may have a hardness of more than 50 degrees.

Mineral spring waters are such as contain mineral matters that are exceptional either in character or amount. They are usually classified, according to the nature of the characteristic ingredient, into saline, sulphur, iron (or chalybeate), magnesia, &c., waters. Many possess marked medicinal properties, but as a rule they are quite unsuitable for domestic or technical purposes.

Sea water varies much in composition in different places and at different depths. It is everywhere characterized by its relatively high content of saline ingredients, these amounting usually to about 34 parts per 1000 in the case of ocean waters. By far the most abundant of these saline ingredients is common salt, this forming usually 75–80 per cent of the total solids, whilst the remainder consists mainly of sulphates and chlorides of calcium, magnesium, and potassium. Owing to the presence of these dissolved solids its density is commonly about 1·03 times that of pure water. [C. C.]

Water, Underground. Experience shows that in most districts enjoying temperate

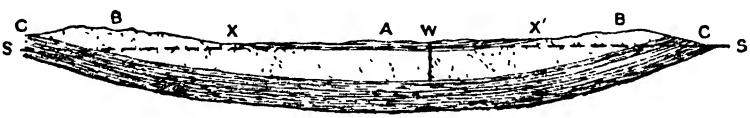


Fig. 1. Section Illustrating an Artesian Water Supply.

A and C, Impermeable strata. L, Permeable stratum, which becomes charged with water under pressure of the head from the regions B and B. An artesian supply will rise in a boring at W. When the water level in B is sufficiently high, as may occur after wet winters, temporary springs and wet ground will occur at X and X'. S, Sea level.

climates there is a level somewhere beneath the soil, below which the ground is saturated with water even in the dry days of summer. The surface of water thus reached in the sinking of wells may be described as the permanent *water-table*. If a boring or well passes through it for, say, 10 ft., the water will stand 10 ft. above the bottom of the well. In some cases, however, water which has descended from higher ground may be prevented from emerging on lower ground by the presence above it at that point of an impermeable layer, such as a bed of clay. It becomes pent in, and is under the pressure of the head of water behind it and above it at the place where it has penetrated the ground; hence, when a well is sunk through the impermeable bed into that which carries the water, the water may rise up to the surface, or even above it as a fountain. Such water is said to be 'artesian'. See fig. 1 for fuller details. (See art. ARTESIAN WELLS.) Where strata are bent into a basin-like form, with an impermeable bed in the centre, and a ring of permeable rock, such as sandstone or limestone, exposed all round, artesian conditions are met with in the central area. *Springs* may emerge in such an area up natural fissures or grouped along fault-lines. Springs also occur where a valley has been eroded through dipping strata, and where a permeable bed rests on an impermeable one below (Fig. 2). Such springs emerge much at the same level along the valley side, and often determine the sites of villages, the opposite side of the valley being perhaps devoid of water supply. The study of detailed geological maps will usually show where there is a probability of obtaining water continuously from permeable strata. While sandstone and limestone may be looked on as water-bearing rocks, it is found that even in these there are certain prominent joint-fissures, along which the underground water principally moves. Hence a well sunk at a little distance from one of known success may prove disappointing. The very success of the earlier one may indicate that it draws on an easily obtained supply, more copious than that which percolates slowly through the minute in-

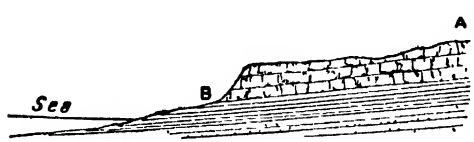


Fig. 2.—Section Illustrating the Origin of Springs.

A, High ground where a good rainfall is received. L, Permeable stratum. C, Impermeable stratum. Springs will emerge at B.

* Figs. 1 and 2 are reproduced by permission from Cole's 'Open-air Studies in Geology' (C. Griffin & Co.)

terstices of the average rock. In limestones, the solubility of the rock in water charged with carbon dioxide allows of the formation of considerable caves and waterways. These, however, often work down to lower levels, leaving their former courses dry. Excellent springs, so far as quantity of water goes, arise in limestone districts; but the water should be tested wherever villages are numerous, since the used water of one area often finds its way down a swallow-hole and emerges elsewhere as a tempting fountain. Fluorescein is commonly used in such tests, and can often be detected in emerging waters after a journey of many hours underground.

The discovery of serviceable springs in regions of massive impermeable rocks, such as granites or compact slates, is a matter of skilled observation, and the unconscious habit of noting the smallest indications of dampness, or change of condition on the surface, may account for the success of some so-called water-finders. There are certainly some regions where, owing to the nature of the prevalent rocks, a geologically instructed engineer at a distance would advise the construction of a surface reservoir, but where close observation may reveal some line of fissure up which water can be successfully drawn by pumping.

Local rainfall is not a sure guide to the quantity of underground water, since this may represent rain that has fallen many miles away. The ordinary sands of the London Basin will hold from 2 to 3 gal. of water in each cubic foot, and 2 gal. per cubic foot appears to be a common figure for white chalk (W. Humber, Water Supply of Cities and Towns, 1876, p. 46). It is, however, a far slower process to draw water through chalk by pumping than it is through sand or gravel.

As a general average, liable to great modifications in districts of different climates and different geological structures, it may be taken that one-third of the rain that falls on a district is returned to the atmosphere by evaporation, even after it has penetrated the soil, one-third is carried away by the streams, and one-third sinks into the soil and subsoil, and contributes to the mass of water underground. An inch of rain on an acre gives 3630 cu. ft., or 22,635 gal. of water, one-third of which may thus come to be stored. [G. A. J. C.]

Water Buffalo. — The so-called Water Buffalo is not a distinct species from the ordinary buffalo of India (*Bos bubalus*). By English-speaking people, the name has been commonly applied to this animal in India and in other countries into which it has been imported for ploughing or heavy vehicular transport, on account of its water-loving propensities. It haunts as a rule low-lying marshy places; and being somewhat scantily clothed with coarse hair, has the habit of burying itself during the hotter parts of the day beneath the water or mud, with only its eyes, nose, ears, and horns visible above the surface, as a protection against the heat of the sun and the irritation of biting flies. See Buffalo. [R. I. P.]

Watercress (*Nasturtium officinale*) is greatly in demand as a salad. Of the several varieties of *N. officinale*, the two mostly cultivated are the bronze and green leaved; the former is the better of the two, its cultivation being restricted to pure running water usually supplied from springs, whereas the green variety is chiefly found growing in still waters, often stagnant.

Of recent years it can safely be said that no cress from stagnant waters ever finds its way to the consumer, as the consignments are sent by large growers, who take every precaution to keep the beds entirely free from all foreign matter and aquatic weeds. The pungent taste of watercress is attributed to an aromatic oil; it also contains sulphur and is rich in mineral matter; and, as a salad, is superior to any other kind of cress, as, *e.g.*, the Common Garden Cress (*Lepidium sativum*) and the American Cress (*Barbarea præcox*). The temperatures of the springs associated with this culture average about 50° F.; thus extremes of heat and cold are guarded against. When a high water-temperature is reached, the plants become yellow and puny—an effect often produced on plants growing some distance from the source of the spring.

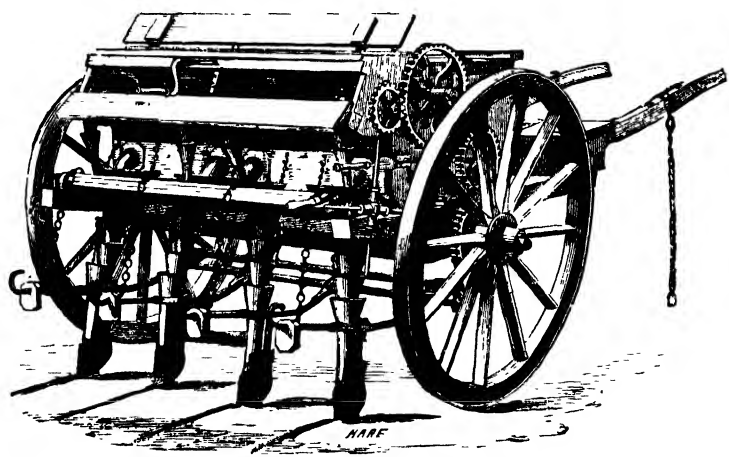
The profits attending this culture are but slight, and do not admit of the formation of new beds except in those positions which offer natural facilities of soil, aspect, and close proximity to a good market. Loamy soil resting on a gravelly subsoil is most to be desired, the loam provides a healthy and firm foothold for the plants, while the firm gravel bottom greatly facilitates cutting. Sandy or peaty bottoms grow good cress; but these soils occasion much expense in keeping up, and the cutting can only be successfully performed by placing planks under the water for the cutters to stand upon. The continuous close cropping of the plants necessitates frequent propagation by taking portions of the old plants averaging 1 ft. in length, and transferring them to newly prepared beds in late summer. Plants from which to propagate are best raised in smaller streams for this exclusive purpose; they then gain a stronger constitution.

An experienced man will cut as many as 100 dozen bunches per day and convey same to the sheds; women are usually employed for tying and bunching, and are paid at the rate of ½*d.* per dozen bunches. The bunches are marketed in flats holding about 18 dozen bunches, or in large hampers (two-bushel) holding from 30 to 36 dozen bunches, according to the season; the smaller number being often packed in warm weather with a piece of ice in the centre to prevent heating. Some growers send cress loose, in which form it is consigned to northern markets by the night mails from London, being packed in hampers holding from 2 to 4 st. Early consignments during February and March give an average return of 6*d.* per dozen bunches, while onwards into June this may be estimated at about 4*d.* [J. C. N.]

Water Divining. — The belief in water diviners or 'dowsers' is widespread. Very few wells—we are not speaking of bored wells—are dug without their assistance. The prospectus of one diviner states that he has been patronized by seven dukes; another claims the patronage of almost as many dukes and two Prime

Ministers, one of whom was a man of the scientific attainments of the late Lord Salisbury Of course the work may quite well have been given out on these notabilities' estates without the knowledge of these distinguished men, but an agent must have been responsible, and the agent of a large estate is a man of education. As a matter of fact, more than one man of science has entered a plea for the painstaking consideration of the water finders' claims. Professor Barrett's and Mr. E. Vaughan Jenkins's collections of evidence as to the results of calling in the users of the divining rod are well known. Again, in a recent correspondence in the Times the water finders did not fare at all badly. But, after all, the strongest argument in their favour is that so many of them exist. It must be supposed that, in a certain average of cases, they are successful, or they would have to go out of business. Then, many of the 'dowsers'' circulars bear the legend, 'No water, no pay'. This intimation is not to be taken too literally, perhaps; but the livelihood of the water finders must depend to a considerable degree on the reputation they obtain for successful discoveries of water. In many cases, no doubt, the success is gained by an ingenious vagueness or by specifying a sufficient number of sites. It is not unreasonable to suppose, also, that some of the water-finding firms are not unacquainted with geological maps and the ordinary sources of information open to engineers And, of course, there is in most districts a large number of places where there is a very good chance of finding water at a reasonable depth. It may also be said that there is just reason for suspicion of trickery in some handling of the hazel (or other) twig The *modus operandi* of the water finder is to cut a forked twig, and, holding an end in either hand, to walk across the ground it is desired to test, until the twig turns smartly round with such force that, if he does not release it, the ends will snap. Sometimes he uses a watch spring, which curls up at the alleged discovery of water. The exhibition is an interesting one to watch, but it would appear that with a little practice the breaking of the twig and the curling of the watch spring could be managed as a trick by persons of dexterity. The experience of the present writer is that of sinking a well 35 ft. and coming on nothing but clay, and then being persuaded by a local well engineer and a local builder to call in a 'dowser', who marked out several lines along which water would be found within a depth of 20 ft.—one site being only 17 ft. away from the sunk well. Some years afterwards an excavation happened to be made on one of these lines, and water was found in gravel within 20 ft The opportunities for coincidence, fraud, and self-deception are so many in connection with water finding that the evidence in relation to the 'dowser's' work needs to be examined with very special care and skill The better opinion as to the diviners seems to be that, in the uncertain state of our knowledge as to the powers of man, it is permissible to believe that, in some persons, there may be a peculiar sensibility to the presence of waters in fissures underground, and that, until the facts are established, the man who wants a well sunk and can have the services of a local 'dowser' of reputation at a moderate fee, or on the 'No water, no pay' plan, may be pardoned for employing him [W. C.]

Water Drills deposit liquid manure and the seeds of root crops simultaneously in rows or drills In place of the hopper provided in ordi-



Water Drill

nary dry-manure drills is a large metal tank, into which water and concentrated manures are put. The tank is divided into three or more compartments connected by ports controlled by sluices to maintain an even quantity of liquid throughout, and to prevent the liquid from overflowing the side when working on hillsides. A spindle passes through the tank from side to side, and on it are disks on the outer rim of which are dredging cups, which lift the liquid as they

revolve and tip it into funnels connected with the coulters. The quantity of liquid distributed is regulated by valves, which are adjustable to allow more or less to fall back into the tank or to pass down the funnels. The seedbox is placed at the rear above the coulters, the funnels connecting with the funnels of the liquid distributor, so that the moistened seed falls into the track with the wetted manure. The spindle of the seedbox is actuated by a cogwheel gearing connected with the nave-driven gearing of the water drill. Apart from the method of liquid distribution, the machine has most of the features of a dry-manure drill. [W. J. M.]

Water Dropwort (*Œnanthe crocata*) is a poisonous perennial marsh plant, belonging to

Water Dropwort (*Œnanthe crocata*)

1, Lower leaf 2, Tuberous roots 3, Single flower 4, Fruit 5, Cross section of fruit, on larger scale

the nat ord Umbelliferæ. It is stout and tall, 3 to 5 ft high, with leaves repeatedly divided, ultimately forming wedge-shaped segments, each segment at least ½ in long and with 2, 3, or 5 lobes at the broad apex. In July the large compound umbel of white flowers is conspicuous at the apex of the stem. When ripe, the fertile flowers form cylindrical fruits, about ½ in long, crowned with 5 minute calyx teeth and 2 long erect styles. Perennial character is assured by the underground stores of food contained in the tuber roots, which are as thick as the thumb, and spindle-shaped. These tubers, mistaken for parsnips, have been eaten with fatal results. Confusion is impossible when we notice that there is but one tuber for each parsnip plant, several for each Dropwort. Sometimes, too, the leaves, mistaken for celery, are eaten and occasion accidents. The celery leaf is divided only once, whereas the Dropwort leaf is divided two or three times. The poisonous principle (*Œnanthin*) is contained in a yellow juice distributed through the whole plant, particularly in the tubers, when the plant is cut this juice readily exudes.

Other species of Dropworts are poisonous for example, *Œnanthe Phellandrium* in ponds, with the roots fibrous, not tuberous; and *Œnanthe fistulosa*, in ditches, with the stem leaves divided only once into few narrow distant segments. Stock should be kept away from marshes where Dropworts grow, and from plants cleaned out from the ditches, otherwise serious accidents may occur [A. N M'A.]

Water Fowl.—The name 'water fowl' is a loose term, having no precisely defined signification, but popularly applied by landsmen to any bird that frequents inland waters or estuaries of the sea. The time has long gone by since birds were classified, as they were by Bewick early in the last century, into land birds and water birds. Nevertheless, there are great groups of birds which are almost wholly water birds, such as the geese and ducks, the herons, cormorants, grebes, divers, petrels, gulls, and the great family of Charadriidæ, or waders. The greatest collections of water fowl that ever occur in England are during very hard winters, when all descriptions of water birds are driven from their breeding haunts in the north of Europe, and congregate in amazing numbers in the estuaries along the eastern coast of England. At such a time many species of duck may be observed together on one sheet of water, geese and swans fly in flocks overhead, and where the water is open, the surface of it is almost black with coots, frozen out of their inland haunts; redshanks and other waders give out their peculiar whistling. A winter such as this is a paradise for punt-gunners, and at every shot fired, the air is filled with the whirring of innumerable wings, as the coots rise in a dark cloud from the surface of the water. The most celebrated of these localities is Breydon Water, a large marshy lake lying at the back of Great Yarmouth, and most of the recent observations on water fowl have come from east-coast naturalists living on or near Breydon Water [H. S. R E.]

Water-glass is the name given to a solution of silicate of soda in water. The silicate of soda is formed by fusing silica with sodium carbonate, or with sodium sulphate and carbon, and extracting the product with water. It forms a thick syrupy solution, and is easily decomposed by even weak acids, such as carbonic acid, with the formation of insoluble silicic acid. In some cases the silicate of soda is mixed with silicate of potash, a substance having very similar properties. Water-glass is now largely used for the preservation of eggs. In this country a 10-per cent solution is generally recommended, but in America as good results have been obtained with a 3-per-cent. The eggs may be dipped in the water-glass solution and then stored upon shelves, or they may be kept immersed until sold or used. The preserving effect is due to the formation of

the insoluble silicic acid, which completely closes the minute pores in the egg-shell, and fresh eggs so treated will keep for a considerable length of time. Water-glass is also used in preparations for checking the decay of stone in buildings, in making artificial stone and cement for furnace linings, and in other ways. [J. W.]

Water Hemlock, or **Cowbane** (*Cicuta virosa*), is an umbelliferous plant containing the deadly poison cicutoxin. Professor Hedrick says that a piece of the root of Oregon Water Hemlock (*Cicuta vagans*) no larger than a walnut is sufficient to kill a cow in about fifteen minutes.

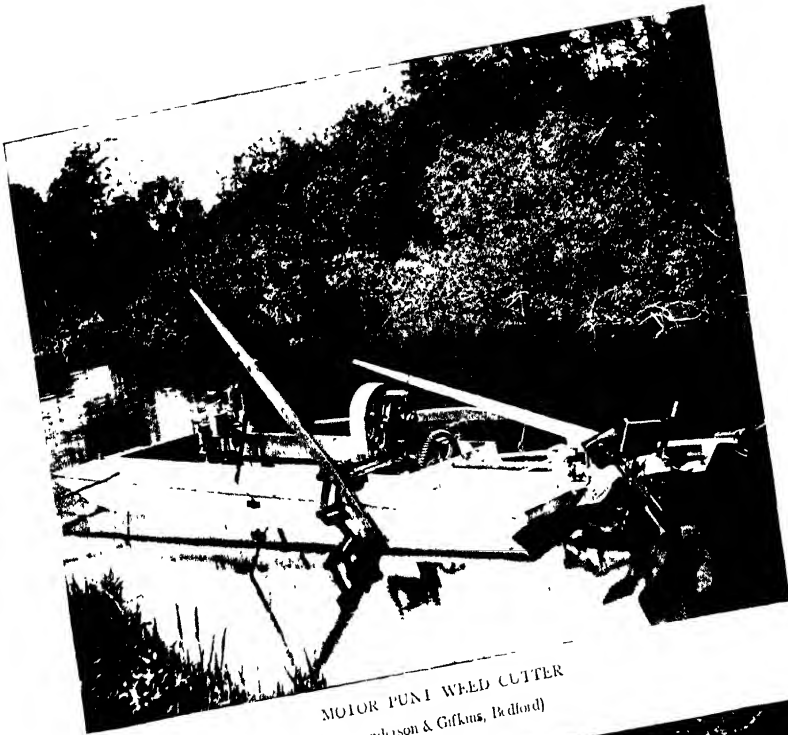
Water Hemlock or Cowbane (*Cicuta virosa*)

1, Lower leaf 2, Flower 3, Fruit 4, Section of carpel 5, Rootstock 6, Section of rootstock

Water Hemlock grows only in water-logged soil—in marshes and along waterways. It is a perennial which renews itself from a short, stout, vertical underground stem (rootstock). This underground part is most deadly, and is easily recognized when cut lengthways by the succession of hollows and cross partitions in its interior. The air shoots are 2 to 4 ft. high, and bear large leaves with blades divided not once, but two or three times. The divisions of the leaf-blade are narrow, lanceolate, over 1 in long, and serrate along the margin. The minute white flowers, produced from July to August, are arranged as flat-topped umbels, 3 to 5 in. across. The fruit is very minute, only $\frac{1}{10}$ in. in breadth, and even less in length. Stock should be kept away from places where this plant grows, and marsh hay containing it should not be given to them. Wherever found, this plant should be hand-pulled and burned, especially the stout underground part—the rootstock. See art. Cowbane, where another figure of the plant is given. [A. N. M'A.]

Water Hen. — The Water Hen or Moor Hen (*Gallinula chloropus*) is one of the best-known of British water birds. It is resident throughout the year in most parts of the British Isles, though in cold weather there is a tendency towards a partial migration southwards. It is, by nature, of a shy and skulking disposition. It is heavy and clumsy on the wing; and when surprised on land in the vicinity of water, will usually run very rapidly to the water's edge, or fly just above the surface of the ground, with its legs hanging awkwardly down. It is an excellent swimmer and diver; and when seen on the surface of the water, it usually swims along with a vigorous nodding motion of the head, and a great display of its white under-tail-coverts. When searching for food on land, the bird is constantly jerking its tail upwards, and is easily recognized from this feature alone. The food consists of worms, slugs, grass, insects both land and water, the larvæ of dragon flies, &c. The nest is usually built in wet places such as among reeds or other aquatic plants, or in the roots of trees standing by the water, but it is occasionally situated on the branches of trees suspended over water, the materials used being taken from water plants. About eight eggs are laid. The call-note is loud and clear, and altogether unlike the cry of any other bird. The name of moor hen is derived from Old English, when 'moor' meant 'marsh'. The water hen can be immediately distinguished from the coot by its different appearance when on the water, by the absence of the bald patch on the forehead, and by the conspicuous white of the under-tail-coverts. [H. S. R. E.]

Watering Animals. — Giving water to horses before feeding them has now superseded the old custom of withholding it until after a meal. The carefully kept records of the army and of large studs prove that fewer cases of indigestion and colic occur under the new system. Water for all stock should be given at the temperature of the atmosphere, and as free from impurities as possible. The preference shown by some animals for pond water that is discoloured, is due to its softness or slight alkalinity. Buildings supplied by pipes should have taps or cocks at short intervals, as a supply running throughout may convey disease from one animal to another. Lead should not be employed in cisterns, in pipes, or in joints under water. All tanks and receptacles should be periodically cleaned out, and ponds treated in like manner, as the seasons serve. In one case of recurring illness in farm stock it was ascertained that a keg of white lead had been thrown into the pond by someone anxious to conceal his theft. The water supply from river, stream, and ditch should be the subject of investigation from time to time, as many causes of illness are traceable to pollution which is not suspected. [H. L.]



MOTOR PUNT WEED CUTTER
(Sanderson & Gifkins, Bedford)

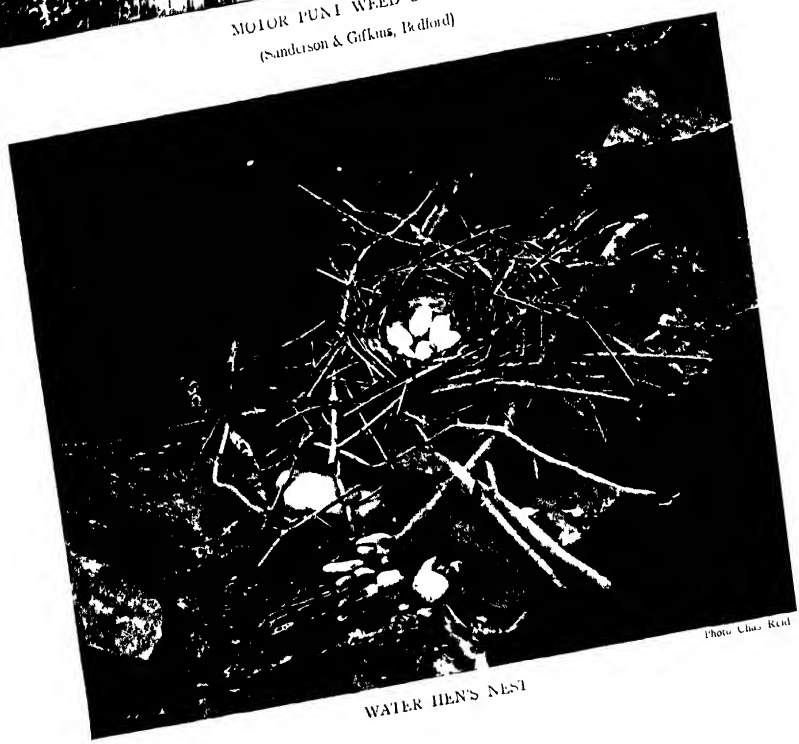


Photo Chas Reid

WATER HEN'S NEST

Water in the Chest. See art. HYDROTHORAX.

Water in the Head. See art. HYDROCEPHALUS.

Water Lily. See NYMPHÆA.

Water Parsnip (*Sium latifolium*) is a perennial creeping plant, belonging to the nat. ord. Umbelliferæ, which communicates taint to the milk of cows that browse it. It occurs on marshy and submerged ground, in ditches, in ponds, and by the sides of streams, often in association with watercresses. The stem is 2 to 4 ft. high, and bears large flat-topped compound umbels of white flowers. The leaf is pinnate, composed of five pairs of leaflets sessile on the midrib, and an odd leaflet at the end. The leaflet itself is over 2 in long, and serrate along the margin. Cows should be kept away from places where this plant occurs.

Another species of Water Parsnip (*Sium angustifolium*) is distinguished by having smaller umbels distributed along the sides of the stem opposite to the leaves, also by the leaflets being lobed as well as serrate. [A. N M'A.]

Water Power. See art MOTIVE POWER IN AGRICULTURE

Water Rail. — The Water Rail (*Rallus aquaticus*) is found in most of the marshy parts of England, while in Scotland, even as far north as the Shetlands, it frequents suitable localities, especially in wintertime. It is usually considered a resident; but there is no doubt that, like nearly all so-called residents, it makes a partial migration in the autumn. In the Norfolk Broads, where the bird is probably more numerous than in any other part of England, a considerable traffic is carried on in the water rail's eggs The bird rarely takes to the wing unless absolutely forced to do so When it does, it is a very awkward flier, and alights promptly at the first bed of reeds that seems to offer promise of security Nevertheless it has been alleged that the bird has settled on a ship at sea, 500 miles from the nearest land. The food consists of slugs, worms, snails, and aquatic plants. During the breeding season the bird gives utterance to a peculiar cry, which in Norfolk is called 'sharming'. The nest is made of reed and sedge, and seven or more eggs are laid in it. The general build of the water rail is such as to facilitate its passage through thick and matted herbage. [H. S. R. E.]

Water Regulations. See art. WATER RIGHTS.

Water Requirements of Animals. —Water plays a part of fundamental importance in the animal economy. Not only is it an indispensable nutrient, but it forms also the medium in which all the vital processes are carried on It serves as solvent and transporting agent for all the nutrients, for the enzymes by means of which the nutrients are digested and utilized, and for the products of these actions. It is required also for the formation of milk and other secretions, and for the removal (as urine) of waste products from the system. Further, it plays a part of the highest importance in regulating the temperature of the body, since in its conversion to vapour large quantities of heat are taken up, and thus removed from the body through the skin and lungs. In this way the excess of heat that liberal feeding always generates in the body is removed, and overheating of the body prevented

The functions of water in the animal system are thus so varied and important that it is easy to understand why serious consequences attend any long-continued deficiency in the supply. The effects of such deficiency are seen first in a slackening of the activity of digestion and resorption, and in less complete removal of the nitrogenous waste products from the body. If the water supply continues to be inadequate the blood gradually thickens, the body temperature rises and fever-like conditions are established, accompanied by a more rapid wastage of the body tissues which soon leads to the death of the animal. The effects of absolute lack of water are indeed more serious and more rapid in their action than those attendant upon absolute lack of food Young animals are especially liable to suffer in their growth from any deficiency or irregularity in their water supply.

Excessive consumption of water need not be feared, unless the animal is compelled to it by the inclusion of excessive amounts of watery food or of thirst-exciting ingredients such as salt in its ration. If, however, excessive consumption of water be continued over any considerable period it will lead gradually to an accumulation of water in the tissues, which in consequence will assume a more swollen and flabby character The digestive powers of the animal will also be weakened. Moreover, the removal of excessive quantities of water from the body will exact from the food supplies of energy which will materially reduce the surplus available for productive purposes.

Opinion is divided as to the precise effect of heavy consumption of water upon milk production, but probably it can, within narrow limits, occasion a temporary increase in the flow of milk.

The amount of water consumed by an animal that is allowed free access to water varies greatly with different individuals and with the same individual under different conditions of feeding, temperature, atmospheric humidity, &c. Milk-producing animals require more water than working animals, and these more than fattening animals of the same class. Young animals consume more water in proportion to their size than old ones, and lean animals more than fat Many substances, such as salt and sugar, if given in more than moderate amounts, lead to increased consumption of water.

It will be clear from the foregoing that it is not possible to lay down definite rules as to the amounts of water required by the different classes of farm animals In general, however, with normal feeding, and at ordinary temperatures, the consumption of water (including water in the food) by animals having free access to it is much as follows:—

	Water consumed per 1 lb Dry Matter in Food
Horse } Sheep }	2–3 lb.
Ox	3–5 ,,
Cow	4–6 ,,
Pig	6–8 ,,

The bulk of the water can, if necessary, be supplied in the form of watery foods, but this is not desirable. Indeed, no matter how watery the food, the animals will usually drink small quantities of water in addition if they have free access to it. From the data given above, it will be clear that, of the common farm animals, pigs are best adapted for dealing with watery food, whilst the amounts of water given to horses and sheep must be relatively small

The temperature of the water supplied to animals should be about 50° to 60° F. If much cooler than this, it may cause catarrh of the stomach, or possibly more serious trouble. Moreover, the supply of the amount of heat required to warm it up to the temperature of the body will be an appreciable drain upon the food For the same reason it is preferable to give the water in several portions, rather than in one large quantity For requirements as to quality, see WATER.

As regards the best practice to follow in watering animals, Kellner makes the following suggestions: Cattle should be watered at each meal after the consumption of the first dry fodder, and should be given as much water as they will consume Horses are best watered before feeding, or otherwise portions of the grain food may be washed out of the stomach into the intestine and be only imperfectly digested. Horses that are overheated or have received no water for a long period must be watered with great caution They should first be allowed to cool down somewhat, and to recover their normal pulse and rate of breathing. With overheated horses it is best to give first a little hay, perhaps just moistened with water, and then every quarter-hour to give gradually increasing amounts of water, starting with small quantities Sheep, pigs, and young stock may safely be allowed free access to water. [C C]

Water Requirements of Plants.—Water is by far the most abundant ingredient of all actively growing plants. It plays indeed a many-sided part throughout the whole existence of the plant. Thus it is an indispensable nutrient, being required notably for the production of carbohydrates. It is further required as solvent and transporting agent for the various food materials that enter the plant and require to be conveyed to the different organs requiring nourishment, as well as for the enzymes, upon whose activity depend the various chemical changes associated with the development of the plant. Moreover, it is the supply of water that determines the turgescence of the cells, upon which the rigidity of the plant so largely depends

All ordinary land-plants take in the water they require by means of their roots only Most of this water passes through the plant and is exhaled in the form of vapour partly through the outer cell-walls of the parts of the plant that are exposed to the air, but chiefly through the openings of the stomata, which are situated mainly upon the leaves There is thus a steady passage of water through the plant, and it is the rate at which this 'transpiration current' flows that more than any other single factor determines the requirements of plants for water The amount of water transpired by plants during their growth varies greatly according to the nature of the plant and the conditions to which it is exposed, *e.g.* intensity of light, humidity of atmosphere, temperature of air and soil, concentration and chemical nature of the salts dissolved in the soil water, &c. It is not surprising, therefore, to find that the results obtained by different observers show great divergences even for the same species of plant Thus in the case of barley results have been published ranging from 262 lb. to 774 lb. of water transpired per pound of dry matter produced in the plant, and for peas from 235 lb to 477 lb We may take 300 lb as a fair average for the ordinary field crops, and on this basis calculate roughly the minimum water requirements per acre for average yields An example of such estimates is given in the following table compiled by Hall ('The Soil', p 86)

	Weight at Harvest	Water in Crop	Weight of Dry Matter at Harvest	Calculated Amount of Water transpired during Growth, assuming rate of 300 lb Water per 1 lb of Dry Matter.	
	tons per acre	per cent	tons per acre	tons per acre	inches of rain
Wheat	2·5	18	2·05	615	6·09
Barley	2·0	17	1·66	498	4·93
Oats	2·5	16	2·10	630	6·24
Meadow hay	1·5	16	1·26	378	3·74
Clover hay	2·0	16	1·68	504	4·99
Swedes	17·0	88	2·04	612	6·06
Mangels	30·0	88	3·60	1080	10·69
Potatoes	7·5	75	1·87	561	5·55
Beans	2·0	17	1·66	498	4·94

It will be seen that in all cases the production of even such moderate crops as are assumed in these calculations demands that a very substantial fraction of the rainfall shall pass through the plants. Bearing in mind that the average annual rainfall over the major portion of Great Britain is not more than 30 in., that much of this falls during the colder months when little or no plant growth takes place, and further that much is quickly removed from the soil by surface drainage, evaporation, or percolation into springs, there can be no doubt that in many seasons the water supply is far from sufficient for the production of the heaviest crops on soils that are unable to supplement the rainfall adequately from underground supplies. The

supply may, indeed, in some cases be insufficient for even an average crop.

Speaking generally, it may be said that in districts where the annual rainfall is not more than 30 to 35 in. the conservation of the water supply becomes a problem of practical importance to be taken into account in the cultivation of the land See art. CULTIVATION, EFFECT ON CHEMICAL AND PHYSICAL PROPERTIES OF SOIL.

Deficiency of water supply to plants shows itself directly in a reduced production of organic matter (*i.e* retarded growth) by the plant In many cases, however, if the deficiency be not too great, the formation of flower and seed is accelerated and the quality of the grain or fruit ultimately obtained is higher than when, with an abundant supply of water, the growth of stem and leaf is prolonged In the case of the finest grades of fruit and some grain crops the advantage derived in this way from a moderate shortage of water may more than compensate for the reduced yield. In the case of fodder crops, however, where weight is all-important, the loss arising from deficient water supply is irreparable [C C]

Water Rights.– The rights and obligations of landowners with regard to water falling on, or flowing through or past their property, fall into three main divisions, namely (1) where water is not confined in any definite channel; (2) where it flows in a definite natural channel; and (3) where it flows in an artificial channel. Only the first two divisions are considered in this article.

1. WATER NOT CONFINED IN ANY DEFINITE CHANNEL –

(*a*) *Surface or Percolating Water and Stagnant Pools* – Flowing water is *res communis*, that is, common property, and cannot be appropriated by any man, but water which is stagnant or which runs in no definite channel is in a different category Thus all water which falls on the surface of the ground belongs to the owner of the land on which it falls, and he may deal with it and appropriate it as he pleases, provided he does so before the water has arrived at, or is flowing in, some natural channel already formed. Moreover, he is entitled to rid himself of it, if he wishes, in a natural manner (As to the law relating to drainage, see under DRAINAGE) Stagnant water, that is to say, a pool which has no distinct or perennial stream of water flowing from it, is also capable of appropriation by the owner of the ground upon which it is situated, who may make what use of it he pleases; but his rights are limited by the obligation to conduct his operations with a due regard to the rights of his neighbours, and so as not to increase the burdens naturally falling on the proprietors of lower-lying ground In the case of springs issuing from the ground, some are so small and so irregular as to form merely indefinite pools of water, while others are sufficiently strong to form for themselves at once a definite channel. In the case of the former, the same rules apply as in the case of percolating or stagnant water, while in the latter case they are regarded as part of the stream, and so are incapable of appropriation or diversion It has also been decided that in the latter case it is not legal to intercept water before it reaches the surface; and the fact that the source of the spring has been built round and formed into a well, will not affect the principle of this decision.

(*b*) *Underground Water and Wells* –The rules of law which apply to casual water on the surface of the ground, apply to subterranean water percolating through the earth in no definite course; while in the case of other water having a definite or known course, the same rules will apply as in the case of watercourses to be explained presently. Consequently, the proprietor of ground under which water flows in no definite channel, is entitled to deal with it exactly in the same way as he would with surface or stagnant water. This question arises most frequently in connection with mines, and here as on the surface the operations must be conducted with a due regard to the rights of one's neighbours. Thus a mine-owner is not entitled to pump into his levels leading to the lower ground water which would not naturally have reached them, just as on the surface the owner of the higher ground is not entitled to increase the burdens of a lower proprietor by pumping up water which might never rise to the surface or which might only do so more gradually and slowly and in much smaller volume. In the exercise of his right to appropriate or divert underground water flowing in no definite channel, springs may be cut off or wells emptied; but such operations give no right of recourse to the owner of the well or spring, nor to a proprietor who has thereby found the flow of water diminished in a stream on which he has riparian rights On the other hand, a proprietor is not debarred from sinking a well in his own ground merely because it derives its supply by percolation from a running stream, thereby diverting a certain amount of the water

2. WATER FLOWING IN A DEFINITE CHANNEL. –An entirely different set of principles come into force in dealing with water which flows in a definite channel. This is *res communis*, and is not capable of appropriation, although every proprietor through whose land it flows has the use of the stream While this is so, the banks and bed of the stream belong absolutely to the proprietor or proprietors whose grounds adjoin; in the case of opposite proprietors, where the river forms a boundary, the dividing line being the central line of the river bed. 'But the title to the soil constituting the bed of a river does not carry with it any exclusive right of property in the running water of the stream, which can only be appropriated by severance, and which may be lawfully so appropriated by anyone having a right of access to it.' The rights of a riparian proprietor are only limited by the rights of those in an analogous position to himself. So, if he be proprietor of both banks he may change the stream as much as he pleases, provided he restores the water to its old channel at a point before it leaves his ground, and provided his action does not affect the stream in its flow, quantity, or quality. It is only proprietors or occupiers of ground bordering on

a stream who have rights to the water, and consequently non-riparian proprietors, apart from contract or servitude, have no rights against riparian proprietors for diversion or pollution of the water.

The rights of proprietors bordering on a stream may be considered under two heads: (1) Those of opposite proprietors, and (2) those of successive proprietors

1. Opposite Proprietors.—A riparian proprietor is entitled to object to any operations which may either cause an alteration in the bed of the stream, or affect its banks, or divert the whole or part of the water. It follows therefore that a proprietor may not, even on his own side of the river, erect anything whatever on the bed of the stream, nor may he remove boulders. The right to object is absolute, since 'the slightest interference with the course of running water may be productive of effects which nobody could foresee or could have contemplated'. It is not therefore necessary for the objecting proprietor to say that damage has resulted, or must necessarily result from the operations complained of While this is true, it does not prevent the defender from showing that the proposed operations are of such a trifling nature as could not by any possibility cause injury. Operations on the banks of a stream stand on a somewhat different footing, for within limits these may be strengthened or supported so as to fulfil their purpose, provided the method of effecting this end does not endanger the lands of the opposite proprietor Everyone has a right to protect himself against damage by flooding if he can do so without injuring his neighbour, and in the case of extraordinary floods a riparian proprietor may exercise a reasonable selfishness in protecting himself, but in order to justify this, the acts complained of must be done to avoid a common danger, and no one can transfer such a danger coming on to his land to that of his neighbour's Thus, where a railway company, finding that by an excessive rainfall a quantity of water had accumulated on the upper side of their embankment and was causing danger to it, cut trenches through the embankment whereby the water flowed on to the lands of the complainant, it was held that though the company had acted reasonably looking to the safety of their own property, yet they were liable in damages, since what they had done was not to drive off a common danger, but to transfer to the lands of the complainant the danger and mischief already existing on their own ground.

2 Successive Proprietors.—

(1) *Limitations of Lower Proprietor.* — The lower proprietor in a question with the upper proprietor is limited only to the extent that he may not dam up water so as to throw it back on the higher proprietor. In such a case the right to object to the operations complained of may emerge although water has not actually appeared on the surface, for the mere overcharging of the soil with water amounts to a nuisance.

(2) *Rights of Lower Proprietor.*—The rights of the lower proprietor in a question with the superior proprietor are to have the stream flowing past him in its natural flow and not changed in quantity or in quality. With regard to the natural flow, any operations which, though not increasing or decreasing its quantity, yet change the speed of the current, may give rise to action. The operations complained of may affect the flow by increasing the speed or changing the direction of the current so as to endanger the banks, or they may affect the flow by decreasing the speed so as to injuriously affect the head of water and thereby decreasing its value to the lower proprietor.

The lower proprietor is entitled to receive the stream without sensible diminution or increase. The case of increase is not so usual as that of diminution, but if water which would naturally have found its way elsewhere be diverted or stored and sent into a stream so as to increase the flow or the quantity to the detriment of a lower proprietor, he would have a good ground of complaint Diminution may take place either by ordinary or primary uses or by extraordinary uses, *e.g.* for agricultural or manufacturing purposes. The primary uses are drink for man and beast, for culinary purposes, for the purpose of cleansing and washing or feeding and supplying the ordinary quantity of cattle Further, under certain circumstances and provided no material injury be done, water may be used and diverted for a time by the upper owner for the purpose of irrigation, and in the same way the upper proprietor may utilize the water of the stream for manufacturing purposes, provided the use was reasonable and such as not materially to interfere with the rights of the lower proprietor The decision of this question will depend upon the facts of each particular instance

Every proprietor is entitled to demand that the stream passing through his lands shall be free from undue pollution No standard of purity can be laid down applicable to all the streams in the country, for as the quality of the air varies in different localities, so does the purity of streams, and the purity of a stream frequently varies at different parts of its course. While therefore it is impossible that a running stream should not receive in its course certain impurities as it passes along, no unnecessary or artificial impurity can be put into it so as to diminish the purity of the water as it passes to the proprietors or inhabitants below. The pollution of the water by any action of a higher proprietor is in itself unlawful, and the objecting proprietor need not show actual injury sustained. Moreover, it is no answer to say that others are polluting the stream; and as the rights of a proprietor are not limited to his present use or enjoyment of the water, a new use will give rise to an action for damages for loss sustained in respect thereof. The law relating to the pollution of streams applies not only to streams flowing in definite courses, but with equal force to surface or percolating water, to stagnant water, and to underground water. Although a proprietor may be entitled to appropriate or divert such water, he must see to it that if it be allowed to find its way on to neigh-

bouring lands it is not contaminated by any action of his.

The pollution of a stream may unfit it for primary uses; but even where a stream is no longer of value for primary uses, the water may still be of value for manufacturing purposes, and in such a case any material increase of pollution which destroys the use of the water by a lower proprietor would give rise to an action of damages; and even although the water is not polluted in the ordinary sense of the word, altering the character of the water has been held to give rise to a ground of action—for example, where mine-owners raised water by pumping from a pit, and discharged it into a stream from which the complainer derives water for distilling purposes. The water of the stream was pure and soft in quality, while the added water though pure was hard, and the amount of added water was sufficient to make the water in the stream as it passed the complainer's land hard instead of soft, and so less suitable for distilling purposes than the natural soft water of the stream. In the circumstances it was held that the mine-owners had 'no more right to pour into the stream foreign water which had the effect of changing its natural quality than they would have to put into it some chemical substance which would produce a similar alteration'.

The common law which has just been explained has been supplemented by Statute, with a view to more effectively checking the pollution of rivers, by the terms of the Rivers Pollution Contravention Act of 1876. By this Act it is declared an offence to put or knowingly permit solid refuse of any manufacturing process or quarry, or any rubbish or cinders, or any other waste or any putrid solid matter to fall or to be carried into any stream so as to interfere with its flow or pollute its waters. The Act prohibits the drainage of any solid or liquid sewage matter into streams unless it is flowing in a channel constructed at the date of the Act, and provided all reasonable means are adopted to render it unharmful. Drainage from manufactories, mines, &c., is also prohibited, but it is provided that if the polluting matter is carried along a channel which was constructed or in course of construction at the date of the Act, no offence shall be committed, provided the party responsible shows that he is using the best available means to render the polluting matter innoxious. Proceedings under the Act can only be taken by a sanitary authority with the consent of the Local Government Board.

The supply of water to houses and districts for primary uses has been provided for by the Public Health Acts, and is outwith the scope of this article. See also under Salmon Fishing, Seashore, Trout Fishing. [D. B.]

Water Supply.—The problem of water supply has engaged the attention of man from the very dawn of civilization, and its solution still remains one of the most important of the tasks that devolve upon modern communities. For not only is water essential to the continued existence of man and beast and every plant, but it is required for a great variety of other purposes, such as the preparation of food, steam raising, washing, and general sanitation. The factors that determine the suitability of a water supply are by no means the same for each of these purposes (see art. Water). It is in particular necessary to discriminate between the requirements as to suitability for drinking purposes or purposes related thereto (*e.g.* in the dairy), and those which determine the value for other purposes.

Drinking Water.—The quality of a water supply for drinking purposes is mainly determined by its freedom or otherwise from organic matter of animal origin. It is practically impossible to insist upon absolute freedom from such contamination, since it is only comparatively rarely that natural waters are found to be absolutely above suspicion in this respect. Still, the water can not be regarded as satisfactory if it shows evidence of more than the very slightest pollution with animal matter; whilst if the bacteriological examination indicates that the contamination, even though slight, is due to sewage, the water must be summarily rejected as highly dangerous to health.

It is utterly impossible to form a reliable opinion as to the quality of a drinking water from its appearance and taste. Many waters highly polluted with sewage are perfectly clear and attractive in appearance. If an analysis is required, the greatest care should be taken in drawing the sample, to ensure that it is representative of the supply.

The kind of information that is sought for in the analysis of water intended for drinking purposes has already been indicated (see art. Water), and it is only necessary further to give here some guidance in the interpretation of the results obtained. The following 'limits' are very commonly used in this connection —

	Upland Surface Waters			Other Waters		
	Organic Carbon and Nitrogen together	Oxygen absorbed in three Hours.	Albuminoid Ammonia.	Organic Carbon and Nitrogen together	Oxygen absorbed in three Hours.	Albuminoid Ammonia
	Parts per 100,000			Parts per 100,000		
Water of great organic purity	not more than 0·2	0·0·1	0·0·05	not more than 0·1	0–0·05	0–0·05
Water of medium organic purity	0·2–0·4	0·1–0·3	0·05–0·1	0·1–0·2	0·05–0·15	0·05–0·08
Water of doubtful organic purity	0·4–0·6	0·3–0·4	0·1–0·15	0·2–0·4	0·15–0·20	0·08–0·1
Impure water	over 0·6	over 0·4	over 0·15	over 0·4	over 0·2	over 0·1

Any such 'limits' must, however, be applied very cautiously, and in arriving at a final opinion the whole of the information obtained with regard to the water must be taken into account. Reference has already been made (see WATER) to the valuable confirmatory evidence of purity or pollution that may be obtained from estimations of the ammonia, nitrates, and chlorine present in the sample. The data on p. 87 indicate what proportions of these ingredients are commonly met with in waters of different types.

Although organic purity is the prime essential of a good drinking water, some importance must be attached to the amount and nature of the dissolved solids and to the 'hardness' of the water. A relatively high content of dissolved solids and a high degree of hardness are commonly regarded as undesirable in drinking waters, but, on the other hand, the best drinking waters are, as a rule, not those which contain only a minimum amount of dissolved solids and are absolutely soft. It is impossible to assign any limits as to the maximum amount of solids that may be regarded as safe Very few really good drinking waters in this country contain more than 50 parts of solids per 100,000 parts of water, the great majority indeed containing far less.

Opinion is divided as to the relative merits of hard and soft waters for drinking purposes. Some credit the calcium and magnesium salts with virtues in connection with bone formation, others blame them for the production of calcareous concretions ('stones') in the body Many regard the presence of magnesium salts as more open to objection in the latter respect than calcium salts. In general fairly soft waters are preferred when obtainable, but they have the drawback of acting more rapidly upon the leaden or other metallic pipes through which the water may be conducted than do hard waters Taking all these considerations into account, perhaps the most suitable hardness will be one of about 5 degree, whilst 25 degrees may perhaps be taken as the maximum that ought not to be exceeded if there is any choice

The commonly used sources of water supply were classified in the Sixth Report of the Pollution of Rivers Commission (1874) as follows:—

Wholesome	1. Spring water 2. Deep-well water	Very palatable
	3. Upland surface water	Moderately palatable
Suspicious	4. Stored rainwater 5. Surface water from cultivated land	Palatable.
Dangerous	6. River water to which sewage gains access 7. Shallow-well water	Palatable.

The main characteristics of these different waters upon which this classification is based have already been explained (see WATER), but a few further remarks are necessary with reference to shallow-well waters and stored rainwater, since these, although classed as suspicious, are very largely used in country districts.

Stored rainwater varies greatly in composition according to the purity of the atmosphere, the collecting surface, and the tank or cistern in which it is stored. The roofs of buildings are commonly polluted with the excrements of birds, with soot from chimneys, &c. Much of this polluting material will be washed down by the rain into the collecting tank. The contamination will be greatest in the first runnings from the roofs after each period of drought; and if these could be prevented from entering the tank, the quality of the water subsequently collected would be very greatly enhanced. In any case, if rainwater is to be used for drinking purposes it should first be filtered through a well-tended filter of animal charcoal (see later) As a rule, however, the pollution is so marked that the water cannot be used for drinking purposes For washing or steam raising, however, it is eminently suitable owing to its 'softness'.

Shallow-well waters are, of all waters used for domestic purposes, the most frequently polluted with sewage and other refuse animal matters. This is attributable to the common practice of sinking the well quite close to the house and without any regard to the proximity of privies, cesspools, manure heaps, or other obvious sources of pollution. In sinking wells, attention should be primarily directed to these points. Where objectionable surroundings cannot be absolutely avoided, special precautions should be taken in the construction of the well to prevent contamination, and the composition of the water should be frequently ascertained

The geological formations most favourable for well sinking are New Red Sandstone, Chalk, and Oolites, but the water from the two latter may be very hard. The well must be properly walled in or 'stemed' with stone, brickwork, or concrete, the joints being made thoroughly watertight with hydraulic lime-mortar or cement. If possible, the wall should further have a backing of concrete or puddled clay. If a bucket is used for drawing the water, the top of the well should be protected by a raised kerb and fitted with a good cover. If the water is drawn by means of a pump, the top of the well should be domed or flagged over. If the water is very soft, the suction pipe of the pump should not be made of lead

Deep wells, if properly constructed, constitute excellent sources for domestic supply, although the water is usually hard. They are only slowly affected by the rainfall, and the level of the water in them is fairly constant. They are always liable to contamination, however, unless provided with an impervious wall as described above.

Springs form the safest of all supplies for the country house, provided that the outcrop of the water-bearing stratum at the point where it yields the spring does not carry any possible source of pollution. If, for instance, the outcrop be of large area and a house or farm buildings be erected at some point of it, the purity of the spring may be seriously impaired thereby.

Streams in country districts may supply a water of good quality provided that the intake be situated at a higher level than any house or other building discharging an effluent into the stream, and that the stream above this point be

well fenced in wherever animals might otherwise be likely to gain access to it.

Water for Dairy Purposes.—The requirements to be fulfilled by a water supply for dairy purposes are practically identical with those for drinking water. The two most prized qualities for dairy purposes are freedom from bacterial contamination, and low temperature. Such a clean, cool water is most readily obtained from springs or deep wells Hardness is in the main a disadvantage in a dairy water, if only on account of the difficulty it occasions in the efficient cleansing of the utensils and cloths.

Water for Consumption by Farm Animals.— The ideal water for stock is one that is pure, not too hard, and not too cold. The hardness should not exceed about 20 degrees (parts per 100,000), but at the same time should not be very low, since the lime in the water will serve to remedy any lack of this ingredient in the food. It is important above all, in the case of growing animals and milk-producing animals, that the water shall not be too soft, or bone troubles may arise. Excessively hard water (say over 50 degrees) tends to make digestion more difficult, and indeed is often refused by horses, the most fastidious of all animals with regard to the character of the water supply Farm animals in general prefer a soft river, pond, or lake water to the best spring or well water. Hardness further requires to be taken into account in boiling foods with water, since many foodstuffs (*e.g* peas, 'roots') are liable to be made hard and less easy to digest if a very hard water be used.

Water rich in iron, such as occurs frequently in moorland districts and is recognizable by its yellow colour which disappears on standing, is said to be unsuitable for milk cows, the yield of milk being thereby reduced It has also been condemned for horses and sheep Green-coloured water owes its colour usually to the presence of algæ, and if otherwise pure may safely be used

Turbid water that does not clear on standing is as a rule contaminated with vegetable and animal matter, and must hence be regarded as suspicious. If it contains putrefactive or disease-producing bacteria or other micro-organisms in appreciable quantities it must be rejected Besides its liability to cause gastric or intestinal catarrh, diarrhœa, &c., such polluted water is frequently the source of intestinal worms and other animal parasites; horses, sheep, and young stock of all kinds being most susceptible to trouble of this nature. Many polluted waters are indeed harmless, but the risks attaching to the use of impure water are too great to be accepted permanently. Rainwater should only be given to animals when other supplies fail, owing to its liability to gross pollution and its extreme softness. See further, Water Requirements of Animals.

Purification of Water.—In dealing with the purification of water it is necessary to distinguish between large-scale methods and those used on the small scale. In both cases, however, apart from the purification effected by 'softening methods' (see later), practically all the more important processes are filtration processes.

On the *large scale* the water after standing for some time in storage reservoirs is filtered through 'beds' of sand and gravel. These filter beds, as usually constructed, are 10 to 15 ft deep, often of very large area, and surrounded by water-tight walls. Collecting drains are placed on the bottom of the 'bed', and over them a layer, about 2 ft. deep, of broken stone, then coarse gravel, fine gravel, and uppermost a layer of fine sand 1 to 4 ft. thick. A head of water of 1 to 4 ft. is maintained at the surface. The greater part of the suspended impurities are retained in the first few inches. This surface layer sooner or later becomes clogged and must be renewed. Filters of this kind are very efficient in removing suspended matters, but have little or no effect upon those which are in solution

On the *small scale*, recourse is also usually had to filtration, a variety of filtering mediums being in use for the purpose. The best of these are animal (bone) charcoal and spongy iron. Whatever the material used in a small filter, it requires frequent cleaning, say every six months, owing to the accumulation of filth upon its surface It is neglect of this precaution that renders domestic filtration mostly a snare and a delusion, the filtered water being often, despite its cleaner appearance, more seriously impure than before filtration. In cleaning the charcoal it should be well washed and then spread out on a tray and either exposed to bright sunlight for a few hours or baked in an oven. If the charcoal is used in the block form it should be well brushed occasionally.

Storage of Water.—If water intended for drinking purposes be stored the cisterns should be of slate, iron, stone, glass, or brick lined with Portland cement Lead should be avoided as far as possible, although indeed many waters have little or no effect upon tarnished lead. If existing lead cisterns are repaired the bright new lead should be exposed to the water for several days and a considerable volume of water passed through the cistern before any is used for drinking purposes. The use of lead must, however, in any case involve considerable risk to the consumer. Zinc is also acted upon by water, and may produce metallic poisoning. Galvanized iron is objectionable for the same reason, and, like wood, is not durable. If iron cisterns are used they should be thoroughly coated with boiled linseed oil before they are painted. A wash of Portland cement, renewed every year, also affords an excellent protection for iron, if carefully applied. Portland-cement concrete (6 parts gravel and broken stone to 1 part best cement), if properly mixed, is an excellent material for the construction of water-tanks. The tank must be cleaned periodically, and this will be greatly facilitated if it be made either round or with rounded corners. All storage tanks should be easy of access and should be provided with good, close-fitting lids.

Action of Water upon Metals.—Reference has already been made to the fact that many waters exercise a solvent action upon

lead and zinc. Copper is also liable to be attacked, whilst the action of ordinary waters upon iron is a very familiar observation.

The greatest importance attaches to the action upon lead and iron, since the pipes used for the conveyance of water are commonly made of one or other of these metals. All waters act upon iron unless deprived of their dissolved oxygen and carbonic acid gas. Iron pipes require therefore to be thoroughly coated with a good protective paint. Wrought iron is usually more rapidly affected than cast iron.

The action of water upon *lead* is usually much slower than upon iron. The danger lies, however, in the fact that lead is a cumulative poison, so that the continued drinking of water containing only traces of lead may eventually give rise to serious lead poisoning. Waters differ greatly in their effect upon lead, some being practically without solvent action. As a general rule, soft waters, especially if impregnated with peaty matter, attack lead much more readily than hard waters The latter, if in the early stages when the lead is new they exert a solvent action, tend to coat the lead with a deposit (basic lead carbonate) which protects it from further action. Waters that exercise an unduly great solvent action upon lead may be improved in this respect by treatment with finely divided carbonate of lime, *i.e.* by increasing their temporary hardness.

Water for Industrial Purposes — The industrial uses of water are many and varied, the most general and important being its use for the production of steam Other uses that may be referred to here are its use for cleansing purposes in the laundry and textile factory, and its uses in the brewery, tannery, and sugar factory.

Water for Steam Raising —It has already been indicated that water for this purpose should have a low content of dissolved solids, especially of hardness-producing solids, and should not contain free acid. Unsuitable water may cause corrosion of boiler plates and formation of deposits ('boiler scale' or 'crust'), which not only may lead to explosions but cause a serious lowering in the heating efficiency of the boiler.

Waters that are rich in dissolved oxygen and carbonic acid have a slow corrosive action on iron, which is increased if chlorides are also present. This action is most pronounced in the case of boilers that are not in continual use. Magnesium chloride is a particularly detrimental ingredient in this respect, since at high temperatures its solutions tend to liberate hydrochloric acid, which is carried away by the steam and may do further mischief in the steam pipes and valves. Iron plates are also corroded by waters that are of acid reaction owing to the presence of peat or other causes.

The boiler scale that arises from the use of ordinary fresh waters consists chiefly of carbonate and sulphate of calcium. If the latter is relatively abundant in the water, the 'scale' is usually much harder and more difficult to remove than when it consists chiefly of carbonate. Attempts are frequently made to prevent the formation of scale by adding different substances ('anti-incrustators') to the water. A great variety of materials have been used for the purpose, including carbonate of soda, common salt, tallow and fatty oils, paraffin oil, and charcoal. This method of treating the water is, however, not to be recommended, and it is far better to soften the water (see later) before it enters the boiler.

Water for Brewing Purposes.—For the manufacture of beer or other beverages, a drinking-water of the highest excellence is required. The water must be free from decomposing organic matters, or it will tend to give rise to putrefaction and growth of moulds during the steeping of the barley upon the malt floors, and may subsequently interfere with the purity of the yeast fermentation. The keeping quality of the beer may also be seriously impaired Water from springs or deep wells is usually preferred to that from any other source The class of beer to be brewed determines whether a hard or soft water will give the best results The relative richness in sulphate of lime of the well waters of the New Red Sandstone around Burton is commonly regarded as one of the factors of importance in determining their excellence for the production of pale ales For stout, porter, and the darker-coloured beers, on the other hand, a soft water is commonly preferred

Water for Laundry or other Washing Purposes —The essential of a good laundry water is that it shall be clean and soft The consumption of soap can then be reduced to a minimum, and its cleansing power more efficiently utilized. With a hard water, not only is the consumption of soap increased, but the soap gives rise to a deposition of insoluble lime salts on the threads of the fabric under treatment, and thereby renders the removal of dirt more difficult This is also a factor of considerable importance in bleaching and dyeing.

Methods of Softening Waters. — It has previously been explained (see art. Water) that the 'hardness' of waters is due mainly to the presence in solution of calcium and magnesium compounds The 'softening' of water thus involves the removal of these substances from solution, and the processes used are directed mainly to this end The most widely-used process is that first introduced by Dr. Clark of Aberdeen in 1841, and still commonly called by his name. This process consists in adding lime to the water, whereby the soluble bicarbonates of lime and magnesia are converted into the normal carbonates. These are insoluble and therefore separate out, and are removed either as sediment or by filtration The following equations indicate the essential nature of the chemical changes involved in the process —

$$\underset{\text{Calcium bicarbonate}}{Ca(HCO_3)_2} + \underset{\text{Slaked lime}}{Ca(OH)_2} = \underset{\text{Calcium carbonate.}}{2CaCO_3} + \underset{\text{Water}}{2H_2O}$$

$$\underset{\text{Magnesium bicarbonate.}}{Mg(HCO_3)_2} + Ca(OH)_2 = \underset{\text{Magnesium carbonate}}{MgCO_3} + CaCO_3 + 2H_2O.$$

The amount of lime required to soften the water may be determined in a small measured

portion of the water by adding to it lime water from a graduated vessel, with frequent shaking, until it is found to give a yellow or brown colour with a solution of silver nitrate.

Clark's process is obviously limited to the removal of hardness due to the presence of bicarbonates ('temporary hardness'), and indeed does not effect this completely if magnesium is present. It does, however, remove iron compounds and a good deal of the organic matter.

The removal of 'permanent' hardness (*i.e.* hardness due to the presence of sulphates and chlorides of calcium and magnesium) is a more difficult problem and has not yet found so ideal a solution. If the water is required for drinking purposes the costly process of *distillation* must be resorted to for the removal of permanent hardness, although simple boiling will precipitate the carbonates and thus destroy the 'temporary' hardness. Distilled water is very tasteless and insipid, but this objection can be largely removed by passing it through a filter of bone charcoal.

If the water is required for steam-raising or washing purposes only, it can be completely softened by the addition of a suitable quantity of either carbonate of soda or soap. These materials precipitate the calcium and magnesium, no matter in what forms they are present in the water, in the form either of carbonates or of combinations with the fatty acids of the soap. The following equations indicate the nature of the changes involved —

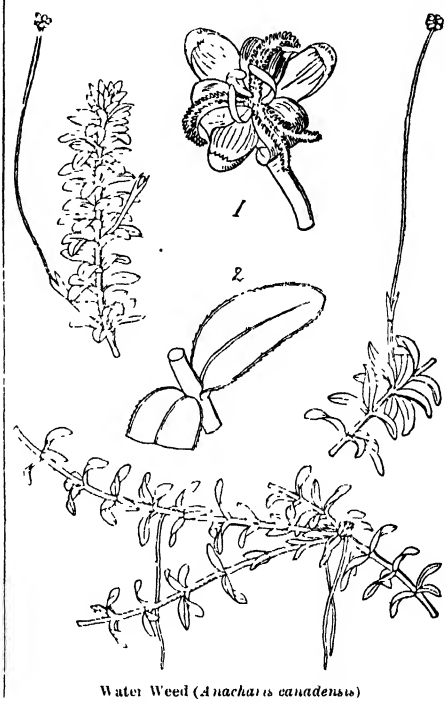
$$\underset{\text{Calcium chloride, soluble}}{CaCl_2} + \underset{\text{Sodium carbonate, soluble}}{Na_2CO_3} = \underset{\text{Calcium carbonate, insoluble}}{CaCO_3} + \underset{\text{Sodium chloride, soluble}}{2NaCl}$$

$$\underset{\text{Calcium sulphate, soluble}}{CaSO_4} + \underset{\text{Sodium stearate (soap), soluble.}}{2NaC_{18}H_{35}O_2} = \underset{\text{Calcium stearate, insoluble}}{Ca(C_{18}H_{35}O_2)_2} + \underset{\text{Sodium sulphate, soluble}}{Na_2SO_4}$$

The defect of this method of softening is that although the lime and magnesia are thrown out of the water, the acids (sulphuric and hydrochloric) with which they were combined (as sulphates and chlorides) remain in solution in combination with the soda (as sulphate and chloride of soda). These soluble 'salts' impart a saline taste to the softened water which renders it useless for drinking purposes. They do not give rise to 'scale', however, in boilers, and hence the water thus softened is greatly improved for steam-raising purposes. The softening is more complete if a little caustic soda be used along with the carbonate of soda. Water-softening preparations usually consist of such a mixture, or of an admixture of lime with carbonate of soda.

It will usually be desirable to soften boiler-feed waters if their hardness is equivalent to more than about 10 parts of carbonate of lime per 100,000 parts of water, as otherwise the rapid accumulation of 'scale' will necessitate very frequent inspection and cleaning of the boiler. [C. C.]

Water Weed, Water Pest, or **Canadian Pondweed** (see ANACHARIS CANADENSIS), is, as all its names imply, a troublesome creeping perennial aquatic. It grows so rapidly and spreads so extensively that serious trouble is caused in ponds, lakes, canals, and sluggish rivers —navigation is interfered with, and angling as well. From Canada this pest has been introduced into Britain, where its spread is assured, not at all by seed, but solely by propagation from leafy shoots. To start with, a portion of a shoot settles down in the mud, where it strikes root, grows, and multiplies, ultimately forming a sward of bottom vegetation. By and by, long shoots grow up from the bottom and branch out,



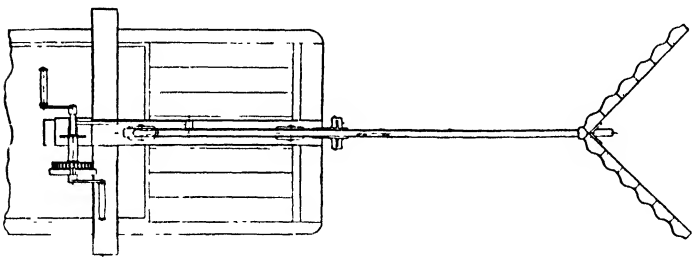
Water Weed (*Anacharis canadensis*)

1, Female flower. 2, Leaves, magnified.

becoming a forest of herbage, effectually blocking any waterway. The shoots are easily recognized by the whorls of simple, undivided, semi-transparent leaves. They are stiff and brittle, so that pieces readily detach, and float away to found new colonies at a distance.

At times, the weed is little in evidence, for it is forming the sward of vegetation at the bottom; but every four or five years, when the long shoots grow up and become rampant, the pest forces itself upon our notice. It is almost hopeless to exterminate the bottom herbage, which is the real source of the evil. We can, however, remove the long water-shoots, thus curtailing the blocking power and the spread of the weed. It is important to burn all the shoots removed —tender treatment is far too risky when we are dealing with growths so tenacious of life and so ready to propagate as the shoots of Water Pest. [A. N. M'A.]

Water-weed Cutters.—The best form of weed cutter is that where two wavy-edged blades are attached to a pole or shaft, forming a V-angle at the lower end. The blades are set horizontally, and when worked with a jerking action readily cut weeds and clear themselves. Any attempt to use modifications of the ordinary mowing-machine knife with fingers has failed, because the weeds cannot be cleared. Weed cutters for use in narrow streams have no mechanical



Weed Cutter operated by hand-power machine fixed in boat or punt

parts, but are made light enough to be worked with hand, like a rake. For larger streams a simple gearing gives a reciprocatory action to the cutter when operated by a man, another man rowing to take the boat forward. For rivers and lakes, a cutter is placed on either side of a steam-driven boat, a small petrol engine being used to operate the cutters. With these, 5 ac. of thick weeds may be cut per hour. On the Nile and in Nigeria, where there is great sudd growth, the weed cutter is used in conjunction with a vertical sudd cutter. A great advantage of the weed cutter as made by Saunderson is that the propulsion and steerage are performed by a pair of paddle wheels at the rear, which also clear away the cut weeds. [W. J. M.]

Water-wheels.—Water-wheels, as distinguished from turbines, are large vertical wheels which are made to rotate about a horizontal axis by water falling from a higher to a lower level. There are three distinct types of water-wheel, viz. the overshot wheel, the breast wheel, and the undershot wheel.

Overshot Wheel.—In this form of wheel, a vertical section of which is shown in fig. 1, the water acts mainly by its weight, though a portion, usually about a half, of the kinetic energy of the entering water is also utilized. The water from the penstock or head-race A passes over the wheel through a sluice or adjustable gate S, and falls against and into the buckets at a little distance beyond the summit of the wheel, and at from 1 ft. to about 2½ ft. below the surface of the water in the head-race.

The buckets are formed in the rim of the wheel, which consists of a cylindrical sole plate B, and two annular disks or shrouds C with a number of vanes or partitions between them. The vanes thus divide up the rim into a number of compartments, called buckets. If R is the radius of the wheel in feet, the number of buckets is usually from 5R to 6R, and their radial depth from about 10 to 15 in. Around the rim of the wheel, and bolted (in segments) to one of the shrouds, there is a circular rack which gears with a small toothed wheel or pinion P so placed as to take the weight of the water off the axle of the wheel and thus reduce the frictional resistance between the axle and its bearings to a minimum. In the lower part of the wheel the buckets move in the opposite direction to the stream in the tail-race. Hence the wheel should be kept clear of the tail water, for if otherwise, it would interfere with the free flow of the stream, causing a resistance and a loss of efficiency.

The efficiency of a wheel is the ratio of the useful work done by it to the energy of the water which is expended in doing it. Let H, in feet, be the total fall from the free level of the water in the head-race to the surface of the water in the tail-race, and let W, in pounds, be the weight of water delivered to the wheel per minute. Then the energy expended per minute would be WH foot-pounds. Of this *available* energy, however, a portion would be lost in consequence of the wheel discharging at a higher level than that of the surface of the tail-race, another portion would be lost at entrance to the wheel, and a further portion would be lost in overcoming the frictional resistances of shaft, gearing, &c.

Let h_3 be the average height above the tail water at which the buckets discharge, and h_1

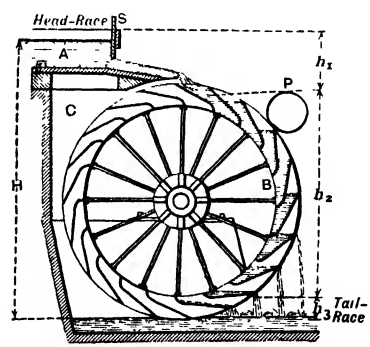


Fig. 1.—Overshot Wheel.

the depth below the surface of the water in the head-race at which the water is received in the buckets, then the portion h_3 of the available head H would be wholly lost; and of the part h_1, only a half, at most, would, theoretically, be available for doing work. Hence the efficiency of the wheel could not be greater than

$$e = \frac{W(H - h_3 - \frac{1}{2}h_1)}{WH} = 1 - \frac{h_3}{H} - \frac{h_1}{2H}$$

This is called the hydraulic efficiency, and is

greater than the actual efficiency since it neglects losses due to the friction of the shaft, &c. Now the peripheral velocity of an overshot wheel should not be greater than 6 ft. per second (it is usually from 4 ft. to 6 ft. in practice), as a greater velocity than this would result in a waste of water from the buckets due to centrifugal force. Further, the most economical velocity, v say, with which the water should enter the buckets is twice the peripheral velocity of the wheel, or say from 8 to 12 ft. per second. Hence $h_1 = \frac{v^2}{2g}$ should be from $\frac{(8)^2}{64} = 1{\cdot}0$ ft. to $\frac{(12)^2}{64} = 2{\cdot}25$ ft., and the diameter of the wheel from about H − 1 ft. to H − 2¼ ft.

The actual efficiency of the wheel is somewhat less than the hydraulic efficiency e, as given in the equation, and usually varies from about 0·7 to 0·8. Hence the horse-power of a wheel working under an available head of H feet and using W pounds of water per minute will be from $0{\cdot}7\ \frac{W\,H}{33000}$ to $0{\cdot}8\ \frac{W\,H}{33000}$.

In iron wheels the vanes are curved, and in one piece, as shown in fig. 1, but in wooden wheels the vanes are in two pieces, as shown in fig. 2, one part, ab, being radial and equal to about half the radial depth, kd, of the buckets.

The chief advantage of overshot wheels is their high efficiency, and particularly in the time of drought, as the buckets, being then only partly filled, discharge at a somewhat lower average level than in times of flood. Its main disadvantage is due to its relatively large diameter and cost of construction. Further, in consequence of its slow peripheral velocity it can only be used advantageously for driving slowly-moving machinery, in which case it is very suitable for available heads of from 10 to 50 ft., and a water supply of from 4 to about 25 cu. ft. per second. Overshot wheels of much greater diameter than 50 ft., however, have been constructed — the wheel at Laxey, in the Isle of Man, probably the largest ever constructed, being 72 ft. 6 in. in diameter—and instead of the power of the wheel being taken from the rim, as in the above example, it is sometimes taken from a toother wheel, or a crank, keyed on the axle.

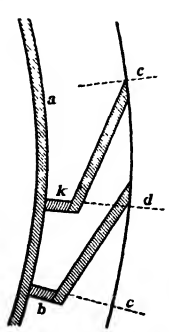


Fig. 2.

Breast Wheel. — A vertical section of a wheel of this type is shown in fig. 3. The water enters the wheel at, or a little above, the level of the axle, through guide passages in the front of the penstock; the supply being regulated by a sluice S, which is adjusted automatically by a centrifugal governor driven from the wheel. Between the bottoms of the buckets and the cylindrical sole plate M there is a passage which allows air to escape from, or enter the buckets as they are being filled by water or emptied. The breast B tends to keep the water in the buckets right down to the level of the tail water, when it escapes with but little velocity. The buckets, as they discharge, are moving in the same direction as the tail-water stream, consequently they may be *drowned* or submerged without causing any interference with the stream. For this reason breast wheels may be used where there are considerable fluctuations in both the head-race and tail-race levels. In this respect, therefore, they have an advantage over overshot wheels. Breast wheels, however, are not so efficient as overshot wheels working under favourable conditions, as the clearance between the breast and the wheel, which for practical reasons cannot be less than about ¼ to ⅜ in., entails a loss of water which varies from 10 to 15 per cent of the whole supply. In addition to this loss of energy there is a loss at entrance, a loss due to the residual velocity in the water as it leaves the wheel, and losses due to the friction between the wheel and curb, to journal friction, &c. These various losses have the effect of reducing the efficiency to about 50 per cent in the case of small wheels and to about 70 per cent in the case of large, well-constructed wheels. Breast wheels which receive the water at a much higher level than the axle are called 'high-breast wheels', and wheels which receive the water near the top and rotate in the same direction as breast wheels but have no breast or curb are called 'pinch-back wheels'.

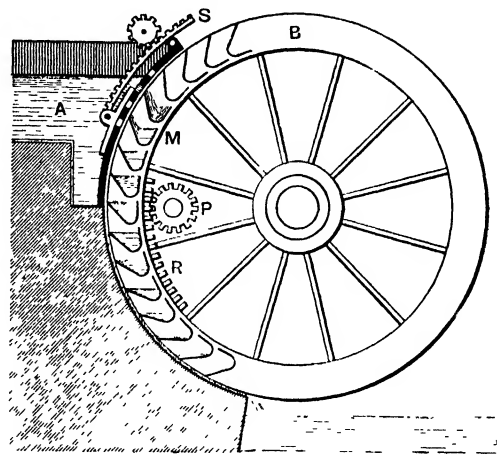


Fig. 3. Breast Wheel.

Undershot Wheel.—In this type of wheel the water is received near the bottom and acts entirely by impulse. A simple type of undershot wheel is shown in fig. 4. It is a wooden wheel, with flat vanes or floats set radially between two annular disks or shrouds B. The water from the penstock A issues in the form of a rectangular stream, the depth of which is regulated by the sliding sluice S, and varies

from a minimum of 8 in. to a maximum of about 20 in. in times of flood. These wheels are made from 10 to 25 ft. in diameter, with vanes from 24 to 28 in. deep, spaced from 18 to 24 in. apart. The maximum theoretical efficiency of these wheels is only 50 per cent, and the actual efficiency is still less, being usually from 35 to 40 per cent. They are only used, therefore,

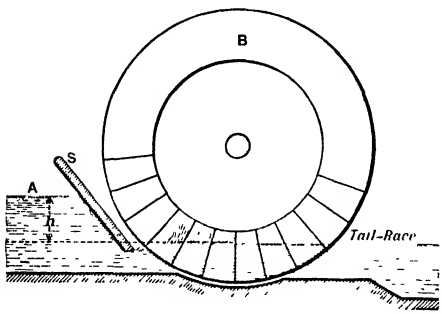


Fig 4 —Radial-vane Undershot Wheel

where there is an abundance of water power, notwithstanding the advantages they possess of being simple in construction and easily kept in repair.

Poncelet Wheel.—A very much improved type of undershot wheel is the Poncelet wheel, shown in fig. 5. It has curved vanes so designed as to receive the water from the penstock without shock and to discharge it in the

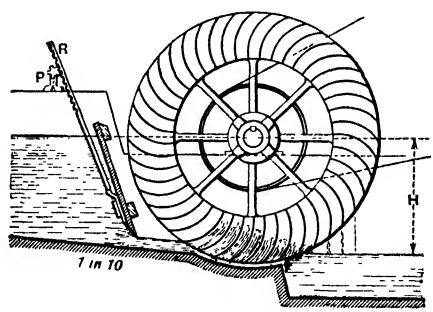


Fig 5.—Poncelet Wheel

tail-race without any velocity of whirl. Theoretically it may have an efficiency of 100 per cent, but practically its efficiency is from about 60 to 70 per cent.

Like other undershot wheels, the speed of rotation of the Poncelet wheel, as compared with overshot and breast wheels, is fairly high, and the wheel may be used to advantage, when the 'head' does not exceed about 6 or 7 ft., for such work as grinding corn, pumping water, &c., or where the application of the power does not require a high velocity. [H. B.]

Watson, Hugh, of Keillor (1789–1865).—'We all look on him as the first great improver, and no one will question his title to that distinction. There is no herd in the country which is not indebted to Keillor blood.' Such was William M'Combie's testimony regarding Hugh Watson and his work. Watson was born on his father's farm of Bannatyne, near Newtyle, Forfarshire, and he became tenant of the neighbouring holding of Keillor in 1808. Polled cattle had been bred by at least three generations of his ancestors, and from his father he received foundation stock for a new herd. Not perfectly satisfied with these, he selected shortly afterwards at Trinity Muir Market, Brechin, the 'ten best heifers and best bull' he could procure. (See art. on Aberdeen-Angus Cattle.) By rigorous selection and inbreeding he then began to evolve a type. Very little is known regarding his early methods. He certainly put the best to the best so long as he received no checks from Nature. In a bull his liking was a somewhat long-framed animal with a round barrel and good hind quarters. No definite records have been obtainable in connection with the first twenty years of his operations. His cattle at their best were superb, if some of their pedigrees were an intricate maze. He was a great exhibitor, but his fame rests on his grand bulls from Tarnty Jock to Old Jock (1), and on a magnificent succession of females. The most notable families of Keillor descent are the Kinochtry Princesses and Emilys from Old Granme (1), the Ericas from Beauty, and the Jilts, Ruths, and Miss Watsons from Beauty of Tillyfour 2nd (1180), M'Combie's purchase at Keillor dispersion in 1860. [J. C.]

Watsonia (Bugle Lily), a genus of very pretty South African bulbous plants (nat. ord. Irideæ) of old introduction, allied to Gladiolus, with long ensiform leaves, usually tall stems, and flowers for the most part pink, scarlet, or violet, one to a spathe, and produced in June and July. They should be grown in sandy loam and peat in pots for greenhouse decoration, but the flowers of plants kept in a frame from which frosts are excluded are finer. They are propagated by offsets or from seeds, and require a season of rest. The species most generally cultivated in gardens include *W. aletroides*, *W. angusta*, *W. densiflora*, *W. humilis*, *W. Meriana* and its varieties, *W. punctata*, *W. rosea*, and *W. strictiflora*. [W. W.]

Wavy Hair Grass. See art. Aira.

Wax is a term employed to denote a great many substances found in the animal, vegetable, and mineral kingdoms. They are all of the nature of fatty matters, but more plastic and lustrous than simple fats. In this article we have only to deal with beeswax, the product of the honey bee. For a long time the production of wax by the bee was wrapped in mystery, the general idea being that it was gathered outside by the bees and brought into the hive. The pollen (fertilizing dust) carried on the hind legs of the bee as it gathers nectar from the flowers was often confounded with it. Somewhere in the middle of the 17th century a Lusatian peasant roughly guessed that it was secreted by the bees from certain glands beneath the abdomen, and exuded in minute scales from between chitinous plates there. Thorley in 1744 confirmed this. Subsequently Hunter (1792) and Huber (1793) established it beyond all doubt. Since then the

subject has been investigated with the utmost care, and many wonderful facts obtained.

In order to produce wax, the bees first gorge themselves with honey and then string themselves by the legs in long plaited festoons from the top of the hive, remaining quiescent, but keeping up a strong heat. The wax then begins to exude from the abdominal plates in minute scales and is seized and drawn out by the hind legs of the bee, from which it is passed on to the fore legs to be salivated and wrought into wax fit for comb-building. The combs of the ordinary kind are about $\frac{7}{8}$ in. thick, with hexagonal cells and rhomboidal bases on each side of the midrib. Drone comb is about $1\frac{1}{4}$ in. thick There are about twenty-five worker cells and sixteen drone cells to each square inch, the ordinary cell being $\frac{1}{5}$ in and the drone cell $\frac{2}{7}$ in measured across It takes the bee under normal circumstances to consume from 13 to 20 lb of honey in order to make 1 lb. of comb. Hence all up-to-date beekeepers now employ comb foundation (sheets of wax with the bases of the cells impressed on them), both for combs in the body box and for sections in the supers. In the combs thick, in the sections very thin, foundation is thus employed It is of the utmost consequence to purchase foundation from a well-known and respectable dealer If it is adulterated with casein and other substances the bees may take to it, but it will sag, and bulge and break away in hot weather, thus causing endless trouble The natural colour of beeswax is a pale-yellow, but much depends on the pollen consumed with the honey—heather yields a white wax, sainfoin an orange-coloured wax. The sides of the cells are generally pure wax, but the covering of broad cells is mixed with pollen. The constituents of wax are carbon, 80·20; hydrogen, 13·14, oxygen, 6·36 per cent. Its sp gr is ·960 to ·965, it becomes plastic at 85° F and melts at 145 to 150 F. All odd combs and bits of wax should be carefully collected and the pure wax extracted therefrom. A very simple way of doing this is to expose it in a fine wire-meshed tray over a pan of boiling water. When the water in the pan cools, it will be covered with a cake of wax, the tray retaining the refuse Other and better methods are by the Solar and Gask wax extractors. [R. M'C.]

Wax Moth (*Aichroia grisella*), one of the worst pests of the bee-hive The moth is of a pale-yellow colour of a satiny sheen, and appears in June and July. Its presence in the hive is generally a sign of neglect See Achroia.

Weasel (*Mustela vulgaris* or *Putorius nivalis*), a common Carnivore in the same genus as the stoat and the polecat. It is smaller than either of them, and is readily recognized by the short tail, which has no black tip as in the stoat. A male is usually about $8\frac{1}{2}$ in. long in the body, with a tail of $2\frac{1}{2}$ in.; for a female the dimensions are about 7 and 2 in. In some cases the weasel turns paler in winter, but there is no marked seasonal change, such as occurs when the stoat becomes an ermine. The colour is reddish-brown above, white beneath, and brown in the tail. As to its habits, the weasel is an active, courageous, pertinacious animal, running swiftly, climbing and swimming well, persistent in its pursuit of field voles, moles, rats, mice, and with an undeniable partiality for young birds. It is said to litter twice (rarely thrice) a year, producing after about six weeks' gestation four to six young ones at a birth. The young are exceedingly playful, and the mother defends them with ferocity. The weasel is common through England, Wales, and Scotland, but does not seem to occur in Ireland. Its practical importance is indubitable, for it is one of the natural enemies

of voles and other rodent pests. It does relatively little damage to game and should not be molested A common Scotch name for the weasel is 'whittret', and the smaller female is sometimes called a 'cane'. [J. A. T.]

Weather, Influence of on Crops.—Apart from considerations of climate, the weather exerts a constant and paramount influence on all crops It is scarcely too much to say that it is the most important factor in determining the yield, and the quality, of every product of the soil, be it agricultural or horticultural The influence of the weather begins to affect crop prospects before the seed is deposited, and continues to do so until the harvest is secured It even extends further, for it affects the condition of corn in the rick, and may be the cause of a rough and damp, or of a bright and dry, sample

In considering the effects of the weather upon crops, the influences of frost, changes of temperature, or rain upon the land cannot be ignored. They are, in fact, most important, for frost is one of the best tillage implements, and alternations of wet and dry help to mellow the ground. The skilful farmer endeavours to act in accordance with the changes of the weather —ploughing up his land in anticipation of frost; and timing his harrowing, rolling, and sowing in such a way as to utilize the changes they produce in the texture of the soil. It is, however, principally after the seed has been sown that the weather influences production. If seed is deposited in a dry, and perhaps cloddy, bed, and the weather continues harsh and dry, germination is sure to be slow and irregular; and after a few weeks of such conditions, hope begins to languish, and partial failure becomes at last inevitable with all crops.

It may, however, be observed that good land is less injuriously affected by bad seasons than poor, thin, and weak land; and it is equally true that well-manured and well-farmed land will stand drought or bad weather better than imperfectly cultivated and impoverished land. Farms which are acknowledged to be thoroughly well managed often escape attacks of rust or blight to a remarkable degree. Their wheat keeps its colour while surrounding fields are turning yellow; their spring corn continues to flourish and their roots to thrive, when on neighbouring farms the barley and oats look pinched and thin, and the turnips and swedes are patchy and stunted. Both may be suffering from drought or cold rains, but the power of resistance and reserve force in the one is far in excess of that of the other.

On the other hand, a beneficent change in the weather produces a wonderful change in crop prospects. A cold and backward spring may have given rise to anxiety, but a warm and genial June may, as has been truly said, put all in tune. A backward spring is not altogether to be deplored, and is even preferable to too forward a season. It is as the season approaches its culminating point that the weather is watched with the greatest solicitude. When the grass is down for haymaking, when the wheat, barley, and oats are fully shot out into ears; when heavy crops are liable to be laid flat by tempest, or torn by hail, or rendered unfruitful by night frosts—this is the period in which the farmer's anxieties with regard to the weather are at their height, and continue so until the harvest is gathered in

What is called an 'all-round good season' is rare in the British Isles. Most years seem to possess a distinctive character Some are droughty, while others are wet; some are extraordinarily hot, while others are abnormally cold, some are suitable for grass and roots, while others are good for corn It is seldom that we meet with a season which favours all crops, and for this reason estimates of yields should always be discounted. An experienced farmer in Northumberland once expressed his opinion to the writer that he considered he lost his entire crop through unfavourable weather once in seven years—if he allowed a discount of about 14 per cent. If we take the root crops as an example, it is probable that in southern England it partially fails about every fourth year. Grass is also uncertain, although it has been truly said that it always grows well *once* in a year. Permanent grass, indeed, escapes many weather risks, and this is one of its strongest points; but roots suffer alike from drought and overmuch wet, as well as from early frosts, which stop their growth. Corn crops are, on the whole, less subject to extraordinary fluctuations in yield than either grass or roots; and the annual reports as a rule vary above and below average, within rather narrow limits. Barley is the most susceptible of our cereal crops, as its value depends so much upon its quality. It suffers from a late spring, but still more from continued rain after it has eared. It is easily thrown down by tempests, and never recovers from the effects of frosty nights before harvest, which are not uncommon. A promising crop of barley may 'go off' in a single night; and, after cutting, the hopes of the grower may be dashed by untimely rain, which deprives the crop of its brightness, stains it, and reduces its value often by ten shillings a quarter.

[J. Wr.]

Nothing is more certain than that as knowledge of weather data accumulates, the farmer will be greatly benefited. The effect of the autumn rainfall, percolation, and wastage of nitrates on the subsequent wheat crop has been clearly demonstrated at Rothamsted by Mr. A. D. Hall. The following figures referring to rainfall alone are sufficient proof that a wet autumn and winter must be followed by a diminished crop of wheat, other things being equal.—

Comparison of 10 Wettest and 10 Driest Winters (1852-1902), Rothamsted

	10 Wettest	10 Driest
Rainfall, Nov. to Feb inclusive	13·01 in.	5·79 in
Average crop per acre, Plots 6, 7, 8	26·2 bus.	34·9 bus

That the converse holds in the case of a dry winter is well shown by the year 1904–5, when the autumn rainfall was 7·81 in., as compared with 1903–4, when it was 17·89 in , while the crop of 1905 was 2·2 bus. above the average of the previous ten years, and 6 bus above the average of 1904. Dr Shaw has shown that the rainfall of a group of counties in the south-east of England is directly and proportionately connected with the wheat crop Dr Nansen has demonstrated that the temperature of the Gulf Stream off the Sogne Fiord in May is a fairly exact guide to the general weather conditions and the crops in Norway in the following year; and the writer has collected evidence to show that the periods of most numerous and fewest spots on the surface of the sun are guides to the earliness and lateness of the harvest in some parts of England and Scotland

Mr. R. H Hooker (Journal of Royal Statistical Society, January, 1907) has stated that not only is the yield of crops influenced by the character of the weather during the growing period, but the weather at seedtime affects the harvest; and Mr. E. P. Sandsten, Wisconsin, by means of elaborate investigations, finds that temperature and other climatic conditions during the summer and autumn preceding flowering of fruit trees have much to do with the time of flowering.

The effect of sunlight upon crops is undoubtedly very great, but the available data are scarce. A comparison of the hours of sunlight in a very good grain year (1874) with a very poor year (1877), near Paris, gives the following figures (from March to July):—

	1874	1877
Total sunlight	6621 hours.	6008 hours.
,, heat	2096 deg.	2053 deg.
,, evaporation	582 mm.	508 mm.
,, rainfall	166 mm.	207 mm.

The excess of heat and sunlight in 1874, the good year, is well marked.

When 'heat constants' are worked out for many places, agriculture may be considerably affected. For example, the Common Syringa, which blooms as early as 29th April at Giessen, and as late as 17th June at Upsala in Sweden, requires for its full maturity, and receives, the same amount of heat or 'insolation sum'. An insolation sum is the daily excess above freezing of the maximum temperature observed when the thermometer is exposed to direct sunlight. At Giessen the Syringa required 1433 deg. and at Upsala 1482 deg. From such a demonstration we may assume that if the heat constants for agricultural plants are known and the insolation sums of different districts are determined, it will be possible to introduce successfully foreign crops in districts where their growth has not hitherto been attempted. Those, however, are more climatic than weather factors. A greater control over the crops as they are affected by the weather is promised by the successful efforts of the Meteorological Department in circulating to farmers telegrams describing the probable weather of the next twenty-four hours.

In 1907 those telegrams sent to farmers were successful in forecasting the weather in 92 per cent of the estimates, while only 1 per cent of the forecasts were total failures. Several farmers reported that the forecasts had saved them from serious losses. See also arts. Altitude, Exposure [R B G]

Weed in Cattle and Horses. The disease intended when persons speak of 'weed' will depend very much upon the district in which it occurs, and the term might well be dispensed with to save confusion. It generally means a painfully swollen limb in which the lymphatics are concerned. In horses it is known as inflammatory œdema, Monday morning leg, or lymphangitis (see Lymphangitis). Thorns and other foreign bodies may give rise to accidental inflammation and much swelling in cattle, when it is also called weed. Wasting from intestinal tuberculosis and from Johne's disease has been called weed, which in some counties is synonymous with wasting in a 'waster', 'skinter', or 'rotten' animal. [H. L]

Weeds are here considered under five heads: (1) Origin, (2) losses; (3) spread; (4) control and extermination; (5) most common arable-land weeds and most common grass-land weeds.

1. The Origin of Weeds.—From the agricultural standpoint, weeds are all plants that interfere with cultivated crops to their detriment, so as to reduce the profit therefrom. Thus Charlock is a weed common in corn, and Yorkshire Fog one common in hay and pasture. All *seed-making* weeds originate either from germinating seeds or from propagative bits of the plant body. Thus Charlock springs from seed, Pearl Grass (Bulbous Tall Oat) from a bit of the plant body often called 'the pearl', Couch from a bit of that part of the plant body often called the 'creeping root', and so on. Crops do not differ from weeds in the mode of their production; thus turnips spring from seed, and potatoes from a bit of the plant body called 'tuber'. Take that most difficult case, namely, the origin of 'natural grasses' in pastures. Every one of these grasses has sprung up either from seed or from a propagative bit of the plant body in the land,—no other source is possible. In addition to seed-making weeds there are the *spore-makers*, which are quite incapable of seed production; such are Ferns, Horsetails, and Mosses. All the spore-making weeds start either from germinating spores, or from propagative bits of the plant body. Thus we see that all weeds take their rise from seeds, from spores, or from propagative organs. Would we, then, reduce the multitude of weeds and minimize the loss they bring, we must use such means as we best can, to reduce the multitude of the weed seeds, spores, and propagative organs in the land, and take such precautions as will prevent contammation with such things.

2. The Losses due to Weeds.—Few realize what loss accrues to a farm, to an agricultural district, to a whole country, from the presence of weeds. Take a very common case on a farm, a field overrun with the yellow Mustard weeds Charlock and Runch. Experiment shows that the upkeep of these weeds has reduced the yield of crop by 30, 40, or even 50 per cent. Take again prevalent fungoid diseases in crops, such as (1) finger-and-toe in turnips, (2) blindness in barley and oats, (3) white rust in cabbages. These diseases can, in certain cases, be traced back to weeds as a source of infection—1 can be traced to Charlock and Runch, 2 to Wall Barley, and 3 to Shepherd's Purse. Consider further such insect attacks on crops as (1) Turnip fly, (2) Mangel fly. The former is sometimes traceable to Charlock; the latter to certain species of thistles. These weeds are the breeding-places of the flies.

Turn now to the eelworm diseases of crops, namely, tulip root in corn, and certain forms of sickness in clover. The eelworms causing these diseases can be traced to the presence of such weeds as Yorkshire Fog, Buttercups, Plantain or Ribgrass, Black Bindweed, Spurrey, &c. Thus weeds are the breeding-places of eelworms as well as fungi.

Weeds affect not only crops but stock. Young cattle are sometimes poisoned by Meadow Saffron, a weed of calcareous pastures. Even dairy produce is not exempt from their influence—witness the taints of the milk and the butter when the cows browse Garlick Mustard, Crow Garlick, Chamomile, &c. These examples taken together show that weeds diminish yield of crop, spread fungoid, insect, and worm diseases, poison stock, and taint dairy produce. That is to say, weeds not only diminish yield of the crop, but also depreciate its quality and add to the cost of production.

3. The Spread of Weeds.—There are various agents of seed dispersal. The chief natural distributors are moving air, moving water, and animals. Everybody knows thistledown. Well, this thistledown is but a tuft of hairs which acts as a sort of flying machine for the thistle seed. Moving air or wind is accordingly the most active disperser of such weeds as thistles, dandelions, and docks,—in short, of all weeds

which have organs of flight, such as hairs or wings, connected with their seeds.

Again, when heavy rains or floods come, seeds are washed away from all sorts of weeds; and these seeds, transported to long distances by rivers, are ultimately stranded, so that the moving water has introduced many new seeds. This explains how all sorts of weeds are found on river banks. Further, such weeds as Burdock, Cleavers, and Meadow grasses (Poas) have hooks or hairs connected with their seeds. When animals are passing, the hooks or hairs fix the seeds to the animals, and so dispersion is assured

In addition to these distributors employed by nature, human beings are in many ways responsible for the spread of weed seeds The farmer, for example, purchases grass, clover, and other seeds and sows them, thus introducing into his land weed seeds, since commercial seeds are never perfectly free from weed impurities If city manure is used, weed seeds are certain to be present, and so extraneous weeds are again introduced. Travelling mills and feeding cakes are other distributors often responsible for uncleanness Accordingly, to keep the land clean, all seeds must be carefully watched.

It is sound policy to burn all weeds bearing mature seeds, and all seeds belonging to weeds To put such things into the farmyard manure is virtually to sow them on the land Keep the dung clean is a good practical maxim Again, to plough mature weeds into the land is a very unsatisfactory proceeding, for sooner or later some of the seeds buried with the plants may germinate and foul the land Even extra-deep burial and lapse of time is very risky, for it is well known that seeds of Charlock and Runch will produce a harvest of weeds when they are brought to the surface, even though the land has lain many years under grass

Some farmers have actually been known to seed their land with weeds, for they sow sweepings of hay-lofts. Actual examination of hay-loft sweepings shows that they usually contain more Yorkshire Fog and Soft Brome than anything else– both of them mere weeds.

Weeds, again, are sometimes sown unwittingly on the land among roadside scrapings In this way pastures have been ruined by the introduction of such wayside pests as creeping Silver Weed and buttercups. Such centres of weed infection as the roadside, the hedges, the ditches, and all waste ground in the neighbourhood of the farm should be well attended to, and the plants on such centres should be regularly cut to prevent the spread of weeds

We proceed now to notice briefly the spread of perennial weeds, which is brought about mainly by the propagative parts of the plant. Like the weed seeds, these parts should be *burnt* or composted. Nothing could be more favourable to the spread of perennial weeds than to throw these propagative parts into the manure heap, and then to apply the contaminated manure to the fields. As it is sound policy to 'keep the dung clean' from weed seeds, it is equally sound to 'keep the dung clean' from propagative organs. The manure heap, then, should be the chief object of solicitude in preventing the spread of perennial weeds from their propagative organs.

4. The Control and Extermination of Weeds by Cultivation.—To make land clean and to keep it clean is one of the main problems of practical agriculture in all countries. First note that any weed whatsoever can be exterminated provided the nature of its growth is understood. The problem is to eradicate with minimum labour and at minimum cost Obviously, when extermination is the object, the weed should be attacked at the weakest stage of its growth. In every *seed-bearing* weed, this stage, at which destruction is most easy, occurs when the seed has germinated—then the whole available store of food has been exhausted in the formation of the seedling If we are dealing with dicotyledonous weeds it is easy to recognize this moment of extreme weakness, which is marked by the appearance of the two first leaves (cotyledons) above the ground, two or three days after, the seedling is at starving-point Now is the time to operate, and bury the seedling with the plough so that light has no access. Or we may uproot with the harrow and cut off the water supply. The burying or the uprooting of the seedling must inevitably kill it Thus is done in spring, since that is the time at which seedlings are naturally produced All the germinative seeds, however, do not germinate together and at once, some sprout earlier than others, and to catch the late-comers, harrowing should be repeated at intervals of two or three weeks. To destroy weeds, therefore, they had best be attacked at the seedling stage of growth. This same principle may be applied in autumn If the stubble is cultivated immediately after harvest so as to cause the weed seeds to germinate and produce seedlings, we may then attack and destroy as before Winter frost will help us, and any survivors will readily be dispatched by cultivation in the spring

The real difficulty of eradication commences when we come to deal with such plants as are not to be caught at the seedling stage of growth. Annuals are easily disposed of, for every year they pass through the seedling stage. So are biennials, since these appear as seedlings every second year, perennials also appear as seedlings, and when they do, are just as easily got rid of as any annual But it is an essential feature of a perennial that has passed through the seedling stage not to start anew as a seedling every year, nor yet every second year, many years must elapse before it dies away and leaves us to deal with the seedling pure and simple. How then are we to destroy, not a young and tender seedling now, but an old-established perennial? We must watch for that period of its life at which it is weakest Now every perennial weed keeps a reserve store of food; if we can catch the plant at a stage in its growth when this food is exhausted, and before it has had time to replenish, this is the weak moment for which we are on the alert. It is among the stubble in autumn, after the grain crop has been removed, that the perennial weed is hungriest and weakest, for ere now much of its available store has been called upon to produce and maintain the new air shoots.

Its half-exhausted resources have not been replenished, because the shade from the grain crop has somewhat retarded the manufacture of replenishing food. Hence the time for attacking an established perennial weed is immediately after the removal of the grain crop; the plant is then at its weakest and the store of food most scanty. If we wait till spring, the store will be partially replenished, and eradication has then become correspondingly difficult. Although burying or uprooting suffices for seedlings, removal and subsequent burning or composting are necessary in the case of perennial weeds, just because the exhaustion of the reserve food is incomplete. If buried they would spring up again by utilizing the food yet remaining, and if uprooted they would again strike root by using this same food store. This process of destroying perennials would be perfect if the removal were complete. Take, for example, the creeping perennial called Couch. This plant invades new territory by means of its creeping underground stem (root-stock), or creeping root as the farmer calls it. Hence, when this plant is pulled by hand or harrow it breaks, and leaves behind just that part from which the plant propagates anew. Take again a Dock, which does not spread horizontally, but merely descends vertically into the depths of the land. Everybody knows how apt it is to break and leave behind a propagative bit. This has ever been the difficulty with perennials—the bits left behind. The principle of getting weeds into a weak state is applied when shade crops such as Lucerne and Vetches are grown to exclude the light from weeds. Lucerne lengthens rapidly and forms a dense growth of herbage, greatly to the detriment of the weeds beneath. The crop is cut several times during the summer, consequently the weeds have no time to seed, and are destroyed in large quantity.

Let us consider then why we cut weeds, and what are the effects of cutting. Here we are dealing in the first place with established annuals and biennials in the first year of their growth. Though we amputate the weed above the first leaves (cotyledons), the effect is not to destroy, seeing that food and buds are left behind. Instead, the dormant seeds develop into new shoots, and several shoots take the place of one. If this first cutting is followed up by a second performed upon the new shoots, and so timed that the reserve food is exhausted, death is the result. Two cuttings may thus be used to destroy annual and biennial weeds, but for perennials the cutting, as will be explained, must be repeated often and in successive years. The scythe catches the annuals, but a hoe or a spud is required to get at biennials with their rosette of leaves upon the ground. Consider again the plough as a cutting implement exercised upon the underground parts of established perennial weeds such as Couch. The 'creeping root' will be cut in pieces, each piece ready to develop into an independent plant. Hence cutting by the plough favours the increase of perennial weeds.

Now let us operate by cutting upon established weeds of any sort—say the Creeping Thistle—with the object merely to prevent seeding. Evidently we must remove the floral region, the part that bears the flowers. The question is, What is the best time to remove this region? The convenient time for us is not necessarily the right time for the plant. We must remove the floral region before the seed is ripe, at a time so early that the part cut off cannot possibly mature its seed. If we consult our own convenience we may cut the thistle so late that the amputated part lying on the ground matures its seed, for after-ripening occurs on cut thistles as well as on cut oats, and if this ripening of the amputated part on the ground goes so far as to bring the seed to maturity, cutting to prevent seeding has been in vain. In the same way the spore-making region may be removed from Horsetails to prevent spread by spores.

Instead of cutting implements, sheep may be used, for they browse down certain species of weeds, not only preventing seeding, but nibbling away the young parts so persistently that the whole plant dies from sheer exhaustion and starvation. The important weeds browsed by sheep are Ragweed, Hardhead, and Ox-eye Daisy. Take Ragweed for example. Only put the sheep early to the pasture, and they will devour the young parts of this weed so greedily that by next year all the Ragweed will have disappeared.

As yet we have described no thoroughly satisfactory plan for exterminating troublesome perennials. We can readily destroy their seedlings when we get them, we can 'draw up' and weaken them under the shade of a grain crop, and then partially or almost totally remove them by autumn and spring cultivation. But propagative bits are left behind by such cultivation, and the question remains, How can perennials be removed completely so that no propagative bits of the plant body are left behind?

The process for the total destruction of a perennial weed can be best exemplified in the case of the common Bracken Fern. The leaves of the Bracken are removed, the new leaves are also removed in successive years as fast as they appear. If this removal of leaves is continued for three or four years, the Bracken dies completely—leaving no propagative bit to continue the growth. This result is accounted for as follows. The reserve store of food is used for leaf production during a period of three or four years. By this time all food in reserve has become exhausted, and the plant dies *in toto* from sheer starvation. The removal of the leaves has prevented the replenishing of the store, inasmuch as the green parts are the only workshops in which food can be manufactured. This plan of exterminating the most troublesome weeds, requiring as it does men, money, time, and patience, may be called the starvation or complete-exhaustion method. Whenever a propagative bit of a weed is left behind, this process should be remembered, as in such cases it will often pay to apply it. We have now seen that the chief practical value of the starvation method is that it converts partial into total extermination.

In conclusion, we note that it is quite possible to exterminate even the most troublesome weeds by the use of ordinary farm implements—the plough, the cultivator, and the roller, the harrow,

the hoe, and the spud. Besides general methods of cultivation, special plans are adopted for the destruction of certain weeds, such as *drainage* for Coltsfoot, Sedges, Rushes, and Horsetails; *liming* for Spurrey; and *spraying* for Charlock and Runch.

5. List of the most Common Weeds.—The common weeds of *arable land* are arranged in three classes

(1) Annuals, (2) Biennials, (3) Perennials.

Class 1. **Annuals**—

Caryophyllaceæ
Common Chickweed (*Stellaria media*)
Spurrey (*Spergula arvensis*).

Chenopodiaceæ—
Fat Hen or Goosefoot (*Chenopodium album*)

Compositæ—
Scentless Mayweed (*Matricaria inodora*)
Corn Marigold (*Chrysanthemum segetum*)
Groundsel (*Senecio vulgaris*).
Annual Sowthistle (*Sonchus oleraceus*)

Convolvulaceæ (Parasitic)—
Clover Dodder (*Cuscuta Trifolii*).

Cruciferæ—
Charlock (*Sinapis arvensis*).
Runch or Wild Radish (*Raphanus Raphanistrum*)
Shepherd's Purse (*Capsella Bursa pastoris*)
Field Pepperwort (*Lepidium campestre*)

Fumariaceæ—
Common Fumitory (*Fumaria officinalis*).

Gramineæ
Wild Oat (*Avena fatua*)
Annual Meadow Grass (*Poa annua*).
Field Foxtail (*Alopecurus agrestis*)

Illecebraceæ—
Annual Knawel (*Scleranthus annuus*)

Labiatæ—
Hemp Nettle (*Galeopsis Tetrahit*)

Papaveraceæ
Field Poppy (*Papaver Rhœas*)

Polygonaceæ—
Black Bindweed (*Polygonum Convolvulus*)
Redshank or Persicaria (*Polygonum Persicaria*)
Knotweed (*Polygonum aviculare*)

Ranunculaceæ—
Corn Buttercup (*Ranunculus arvensis*)

Rubiaceæ—
Cleavers (*Galium Aparine*)

Scrophulariaceæ—
Field Speedwell (*Veronica agrestis*)
Yellow Toad-flax (*Linaria vulgaris*)

Class 2. **Biennials**—

Compositæ—
Burdock (*Arctium Lappa*).
Spear Thistle (*Carduus lanceolatus*)

Umbelliferæ—
Wild Carrot (*Daucus Carota*).

Class 3. **Perennials**—

Composite—
Creeping Thistle (*Carduus arvensis*).
Coltsfoot (*Tussilago Farfara*).

Convolvulaceæ—
Small Bindweed (*Convolvulus arvensis*).

Equisetaceæ (Spore-makers)—
Field Horsetail (*Equisetum arvense*).

Gramineæ—
Couch (*Triticum repens*).
Bent (*Agrostis vulgaris*)

Labiatæ—
Field Mint (*Mentha arvensis*).

Umbelliferæ—
Goutweed (*Ægopodium Podagraria*).

Urticaceæ—
Great Stinging Nettle (*Urtica dioica*).

The common weeds of *grassland* are arranged in three classes.

(1) Annuals, (2) Biennials; (3) Perennials.

Class 1 **Annuals**—

Caryophyllaceæ—
Mouse-ear Chickweed (*Cerastium triviale*)

Gramineæ—
Soft Brome (*Bromus mollis*)

Linaceæ—
Purging Flax (*Linum catharticum*)

Scrophulariaceæ
Yellow Rattle (*Rhinanthus crista galli*).

Class 2 **Biennials**—

Compositæ
Spear Thistle (*Carduus lanceolatus*).

Umbelliferæ—
Wild Carrot (*Daucus Carota*)

Class 3 **Perennials**

Colchicaceæ—
Meadow Saffron (*Colchicum autumnale*).

Compositæ—
Creeping Thistle (*Carduus arvensis*)
Knapweed or Hardhead (*Centaurea nigra*)
Ox-eye Daisy (*Chrysanthemum Leucanthemum*).
Daisy (*Bellis perennis*)
Ragweed (*Senecio Jacobæa*)
Dandelion (*Taraxacum officinale*).
Mouse-ear Hawkweed (*Hieracium Pilosella*).
Cat's-ear (*Hypochæris radicata*)

Cyperaceæ
Sedges (Carex)

Filicineæ (Spore-making Plants)—
Bracken (*Pteris Aquilina*)

Gramineæ
Yorkshire Fog (*Holcus lanatus*)
Creeping Soft Grass (*Holcus mollis*).
Bent (*Agrostis vulgaris*)
Tufted Hair (*Aira cæspitosa*)
Sweet Vernal (*Anthoxanthum odoratum*).
Couch (*Triticum repens*)
Bulbous Tall Oat (*Arrhenatherum avenaceum*).
Meadow Barley (*Hordeum pratense*)

Juncaceæ
Rushes (Juncus)

Labiatæ—
Selfheal (*Prunella vulgaris*).

Leguminosæ—
Restharrow (*Ononis spinosa*).
Broom (*Sarothamnus scoparius*).
Gorse or Whin (*Ulex europæus*)

Plantaginaceæ—
Plantain or Ribgrass (*Plantago lanceolata*).

Polygonaceæ—
Common Dock (*Rumex obtusifolius*).
Sorrel or Sourock (*Rumex Acetosa*).
Sheep's Sorrel (*Rumex Acetosella*).

Primulaceæ—
Cowslip (*Primula veris*).

Ranunculaceæ—
Upright Buttercup (*Ranunculus acris*)
Creeping Buttercup (*Ranunculus repens*).
Bulbous Buttercup (*Ranunculus bulbosus*).

Rosaceæ—
Silver Weed (*Potentilla anserina*).

Umbelliferæ—
Cow Parsnip (*Heracleum Sphondylium*).
Earthnut (*Conopodium denudatum*).

Urticaceæ—
Great Nettle (*Urtica dioica*).
Small Nettle (*Urtica urens*).

[A. N. M'A.]

COMMON WEEDS OF GRASS LAND

A Upright Buttercup (*Ranunculus acris*).

1 Petal.
2 Calyx

B Self Heal (*Prunella vulgaris*

1. Calyx
2 Stamen

C Ragweed (*Senecio Jacobea*

1. Detached flower

D. Knapweed (*Centaurea nigra*)

1. Detached flower

COMMON WEEDS OF GRASS LAND

Weeds as Soil Indicators

The weeds in a given district, or even on a particular farm, vary considerably according to the prevailing soil The herbage, for example, on low-lying damp meadows will be quite different from that on highly situated fields on the same farm, while the weeds of light sandy or calcareous soils will almost certainly be widely different from those on heavy clays or marshy land. So much indeed do the species of weeds, as well as the strength or otherwise of their growth, vary on distinct soils, that they are frequently regarded as indicators both of the type and quality of the soil. To take an extreme example, a marshy plant like the Bulrush would not occur on a high, dry, light soil, while Spurrey is regarded as a sign of the absence of lime on light land While, however, some plants are more or less confined to certain types of soils, many are so widely distributed without reference to soil that they cannot be regarded in any sense as soil indicators. 'It has ever been known that different wild plants affect peculiar soils. Thus, land on clays, limestones, sandy tracts, and the mixture of these which we may term loams, will each grow weeds peculiar to itself; and though some kinds of weeds will grow everywhere, yet a correct observer may form very accurate notions as to the nature and properties of a soil by examining its spontaneous vegetation' (Morton's Cyclopedia of Agriculture, 1856)

Grasses have been found to be particularly good soil indicators, but many of the more common weeds of various natural orders are especially found on soils of a certain character It is probable that the chemical composition of soils has a greater influence than the physical, while it is well known that moisture-retaining capacity, the proportion of humus, the presence or absence of lime, conductivity to heat, and other factors, are of very considerable importance in determining the flora which will best flourish on the soil of a district.

It must be pointed out, however, that any list that can be given is not to be accepted as arbitrary and absolute, but rather as suggestive. A soil must not be held poor solely because a certain weed is found on it, nor rich or good merely owing to the presence of other weeds The character of a soil is indicated perhaps more by the manner in which the weeds grow than by the fact that they are present—there is a wide difference between the occurrence of a few stray plants of Spurrey in a good arable field and the overwhelming quantities which are often found on light sandy soils in which lime is almost absent On good land, weeds tend to grow large and luxuriant, as do cultivated crops, while on poor land they will often be the reverse; for example, thistles, buttercups, and cowslips only grow at their best on good land, being usually much smaller and even stunted on poor soils.

Bearing in mind the reservations mentioned above, it may be stated in general terms that plants on sandy soils are *calcifuges* and *xerophytic*, or are intolerant of lime and associated with a dry soil, weeds on calcareous soils are associated with a demand for lime, and 'the lighter calcareous soils are notoriously weedy' (Hall), on loams, weeds are scarcely characteristic, such soils being more or less suited to all kinds of plants, though there are some weeds which especially indicate good rich soils, while clay soils are perhaps generally less weedy than others, being close in texture, cool and retentive of moisture, though some species are particularly noxious on such land. Heavy clays are perhaps subject to fewer weeds than any other class of soil, while calcareous loams are characteristically rich in the number of species which grow plentifully

Having explained thus much the general way in which weeds are soil indicators, it will be useful to give a suggestive list of species which, with the specified reservations, point to the classes of soils referred to in each case below.

Weeds on Good Loamy Soils

Buttercups (*Ranunculus* sp.).
Thistles (*Cnicus* sp.)
Coltsfoot (*Tussilago Farfara*).
Stinging Nettles (*Urtica* sp.).
Groundsel (*Senecio vulgaris*).
Goosefoot or Fat Hen (*Chenopodium album*)
Cleavers (*Galium Aparine*)
Dandelion (*Taraxacum officinale*).
Chickweed (*Stellaria media*).
Annual Sow-thistle (*Sonchus oleraceus*)
Scarlet Pimpernel (*Anagallis arvensis*)
Fumitory (*Fumaria officinalis*).
Corn Cockle (*Agrostemma Githago*).
Shepherd's Purse (*Capsella Bursa pastoris*).
Charlock (*Sinapis arvensis*)
Spurges (*Euphorbia* sp.).
Speedwell (*Veronica* sp.)
Fool's Parsley (*Æthusa Cynapium*)
Rychke Brome Grass (*Bromus secalinus*).
Darnel (*Lolium temulentum*)

Weeds of Poor Soils

Spurrey (*Spergula arvensis*)
Ragwort (*Senecio Jacobæa*)
Ox-eye Daisy (*Chrysanthemum Leucanthemum*)
Rest Harrow (*Ononis spinosa*)
Sheep's Sorrel (*Rumex Acetosella*)
Dyer's Green-weed (*Genista tinctoria*).
Quaking Grass (*Briza media*).
Yorkshire Fog (*Holcus lanatus*).
Sterile Brome Grass (*Bromus sterilis*)
(Absence of Clover)

Weeds of Damp Soils

Rushes (*Juncus* sp.).
Sedges (*Carex* sp.)
Tussock Grass (*Aira cæspitosa*)
Floating Foxtail (*Alopecurus geniculatus*)
Horsetail (*Equisetum* sp.).
Silver Weed (*Potentilla anserina*).
Cowslip (*Primula veris*).
Butterbur (*Petasites vulgaris*).
Knotgrass (*Polygonum aviculare*)
Lady's Smock (*Cardamine pratensis*).
Meadow Sweet (*Spiræa Ulmaria*)
Ragged Robin (*Lychnis flos Cuculi*).
Mosses (*Musci*).
Orchis (*Orchis* sp.)
Lousewort (*Pedicularis palustris*)

Weeds of Clay Soils

Corn Buttercup (*Ranunculus arvensis*)
Perennial Sow-thistle (*Sonchus arvensis*).
Coltsfoot (*Tussilago Farfara*)
Dyer's Green-weed (*Genista tinctoria*).
Rest Harrow (*Ononis spinosa*).

Primrose (*Primula veris*).
Wild Carrot (*Daucus Carota*).
Black Bindweed (*Polygonum Convolvulus*).
Wild Oat Grass, Havers (*Avena fatua*).
Slender Foxtail (*Alopecurus agrestis*).
Marsh Bent Grass (*Agrostis alba*).

Weeds of Calcareous Soils

Viper's Bugloss (*Echium vulgare*).
Chicory (*Cichorium Intybus*).
Field Madder (*Sherardia arvensis*).
Penny-cress (*Thlaspi arvense*)
Scabious (*Scabiosa* sp.)
Fumitory (*Fumaria officinalis*)
Bladder Campion (*Silene inflata*)
Corn Gromwell (*Lithospermum arvense*).
Erect Brome Grass (*Bromus erectus*)
Bent (*Agrostis stolonifera*)
Downy Oat Grass (*Avena pubescens*)
Quaking Grass (*Briza media*)

Weeds of Sandy Soils

Corn Gromwell (*Lithospermum arvense*).
Spurrey (*Spergula arvensis*)
Sandworts (*Arenaria* sp.)
Corn Blue-bottle (*Centaurea Cyanus*).
Poppy (*Papaver Rhoeas*)
Foxglove (*Digitalis purpurea*)
Hemp Nettle (*Galeopsis* sp.)
Gorse (*Ulex* sp.)
Heather (*Calluna vulgaris*).
Heaths (*Erica* sp.)
Broom (*Cytisus scoparius*)
Sheep's Sorrel (*Rumex Acetosella*)
Bracken (*Pteris aquilina*).
Corn Marigold (*Chrysanthemum segetum*)
Annual Knawel (*Scleranthus annuus*)
Hair Grasses (*Aira* sp.)
Wall Barley Grass (*Hordeum murinum*)
Bulbous Oat Grass (*Arrhenatherum avenaceum* var *bulbosum*)
Sterile Brome Grass (*Bromus sterilis*)

It will be observed that some of the species named above occur under two headings. This indicates, for example, that Rest Harrow or Dyer's Green-weed occur on poor clay soils, that Spurrey, Sheep's Sorrel, and Sterile Brome Grass occur on poor sandy soils; the Primrose on damp clay land; while Corn Gromwell may be found plentifully on light sandy or calcareous soils, and so forth. [H. C. L.]

Poisonous Weeds

A very considerable number of weeds and other wild plants are either rankly poisonous or of a toxic character, while there are several which especially affect the milk of cows which eat them, as well as the butter and cheese manufactured from such milk. It is of the greatest importance that such plants should be recognized by farmers, as very considerable losses may be sustained owing to the unobserved presence of a plant like Meadow Saffron (*Colchicum autumnale*). To give point to this, it may be mentioned that in Staffordshire a farmer lost seventeen milking cows in one year, in the autumn of 1908 he lost seven calves, and in 1909 a number of sheep and cows, and it was not until all this stock had been lost that a considerable quantity of Meadow Saffron and Water Hemlock was discovered in the field in question. Numerous cases in connection with many other poisonous plants could be cited. The individual species are dealt with under their own names, but it will be convenient to give a brief list of those species which are most common or most important owing to their poisonous properties.

Name	Poisonous Parts
Monkshood (*Aconitum Napellus*)	Whole plant, especially root
Buttercups (*Ranunculus* sp.)	Most buttercups are acrid or poisonous in the green state, especially *R. sceleratus* and *R. flammula*
Poppy (*Papaver* sp.)	All parts
Corn Cockle (*Agrostemma Githago*)	Seeds
Laburnum (*Cytisus Laburnum*)	All parts, especially seeds
Bryony (*Bryonia dioica*)	All parts, especially berries
Hemlock (*Conium maculatum*)	All parts
Cowbane or Water Hemlock (*Cicuta virosa*)	Especially the rootstock
Water Dropwort (*Oenanthe crocata*)	All parts, especially roots
Fool's Parsley (*Aethusa Cynapium*)	All parts
Hound's Tongue (*Cynoglossum officinale*)	Whole plant
Deadly Nightshade (*Atropa Belladonna*)	Whole plant
Henbane (*Hyoscyamus niger*)	All parts
Bittersweet (*Solanum Dulcamara*)	Stem, leaves, and berries
Black Nightshade (*Solanum nigrum*)	Chiefly berries
Foxglove (*Digitalis purpurea*)	All parts, especially seeds.
Dog's Mercury (*Mercurialis perennis*)	Whole plant.
Annual Mercury (*M. annua*)	Whole plant
Caper Spurge (*Euphorbia Lathyris*)	Especially the seeds
Box (*Buxus sempervirens*)	All parts
Yew (*Taxus baccata*)	All parts except the scarlet mucilaginous cup enveloping the seed
Oak (*Quercus* sp.)	Acorns
Meadow Saffron (*Colchicum autumnale*)	All parts
Cuckoo Pint (*Arum maculatum*)	All parts
Darnel (*Lolium temulentum*)	Grain only
Ergot (*Claviceps purpurea*)	A poisonous fungus parasitic on rye and grasses.

The foregoing are the species which are most likely to be troublesome. It may be said, however, that the following plants are poisonous or irritant in varying degrees: Wood Anemone, Larkspur, Hellebore, Greater Celandine, Charlock, Spindle Tree, Common Buckthorn, Indian Tares (*Lathyrus*), Lupins, 'Java' Beans, Cherry Laurel, Rhododendron, Azalea, Thorn-apple, Potatoes under certain conditions, Sheep's Sorrel, Spurge Laurel, Mezereon, Castor-oil Plant, *Cupressus*, Herb Paris, and Lily of the Valley.

It may be added that the following wild plants have been found to contaminate the milk of cows which eat them. Field Garlic (*Allium*

WEEDS COMMON TO ARABLE AND GRASS LANDS

A Creeping Thistle (*Carduus arvensis*

1 Detached flower

B Spear Thistle *Carduus lanceolatus*.

1 Detached flower

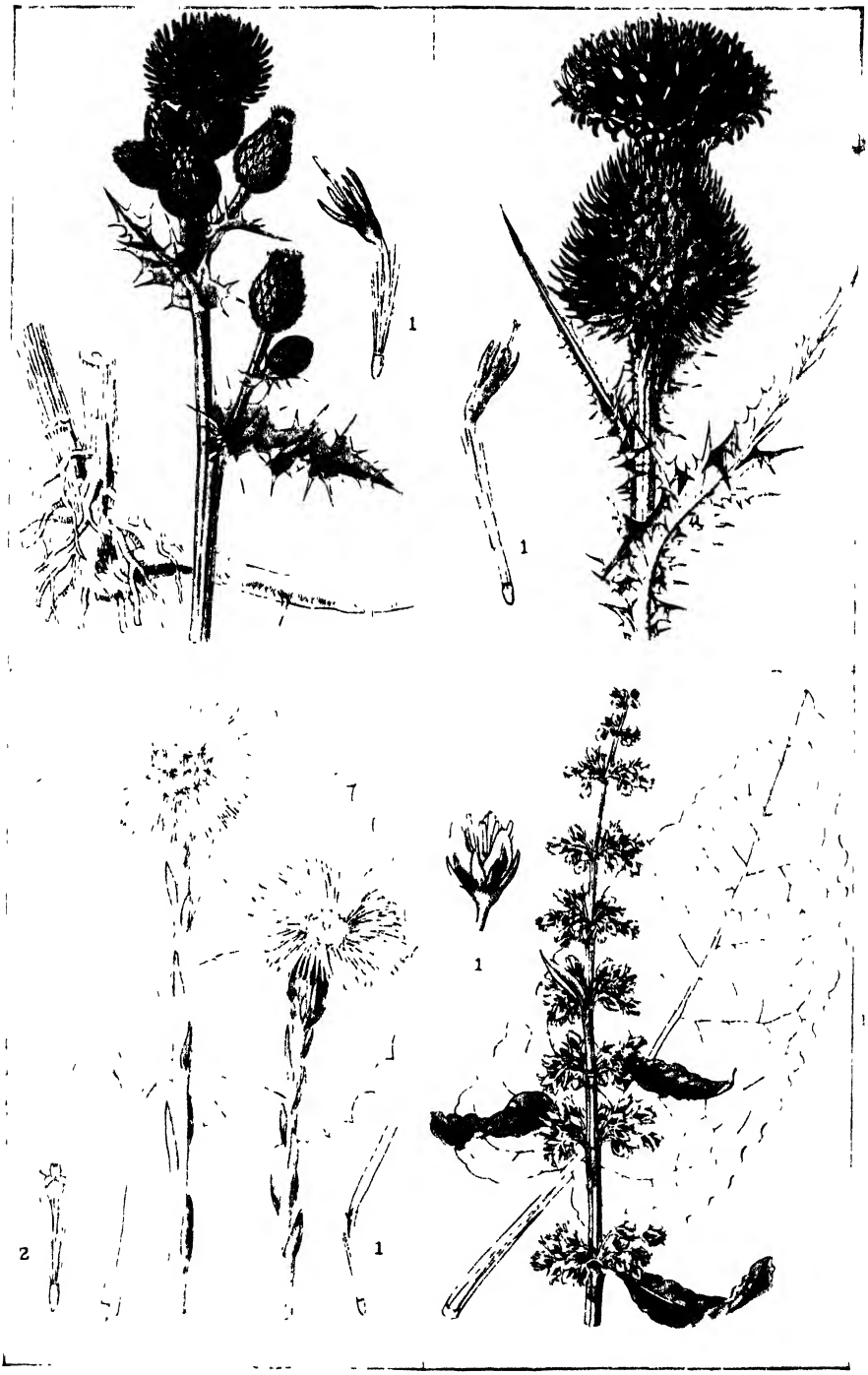
C Coltsfoot *Tussilago Farfara*

1 Ray flower detached

2 Disc flower detached.

D Broad-leaved Dock *Rumex obtusifolius*.

1 Detached flower



WEEDS COMMON TO ARABLE AND GRASS LANDS

oleraceum), Ramsons or Broad-leaved Garlic (*A. ursinum*), Crow Garlic or Wild Onion (*A. vineale*), Chamomile (*Anthemis*), Ivy (*Hedera*), Acrid Buttercup (*Ranunculus acris*), Garlic Mustard (*Alliaria officinalis*), and others. Some of these may also seriously taint the meat of stock ready for the butcher and render it unfit for food—mutton, for example, has been quite spoiled owing to sheep having been grazed in a field containing much Broad-leaved Garlic

[H C L]

Special Methods of Eradicating Weeds

The ordinary tillage operations are perhaps generally effective, when properly utilized, in keeping down the great majority of weeds There are, however, a number of means which may be usefully employed in particular cases and with certain weeds, but which are not sufficiently recognized and put into practice Several of these special methods of dealing with weeds will be referred to here

Liming.—The influence of lime in reducing certain weeds is remarkable, and might be more widely utilized. In referring to this point, Hall says 'The presence of Sheep's Sorrel, Spurrey, Corn Marigold, or Bracken in arable land is a pretty sure sign of the absence of lime In the Rothamsted experiments the effect of lime on the herbage was striking, and Sorrel was practically eradicated; and in Somerville's experiments on grassland in Cumberland the application of lime was found considerably to reduce the percentage of Yorkshire Fog and *Agrostis* The reason that lime is effective appears to be that the weeds concerned are in varying degree intolerant of lime, preferring soils in which this substance is almost absent Among weeds against which lime may be expected to prove valuable may be mentioned

Sheep's Sorrel (*Rumex Acetosella*)
Common Sorrel (*R. Acetosa*)
Spurrey (*Spergula arvensis*)
Corn Marigold (*Chrysanthemum segetum*)
Heaths (*Erica* sp.)
Ling or Heather (*Calluna vulgaris*)
Bracken or 'Fern' (*Pteris aquilina*)
Yorkshire Fog (*Holcus lanatus*)
Wavy Hair Grass (*Aira flexuosa*)
Bent Grasses (*Agrostis* sp.)
Various mosses

Growth of Dense Crops.—Weeds may be suppressed by the cutting off of the light-supply, and one valuable method which has pronounced effect in this way consists in growing heavy crops of tall fodder plants In the southern counties perhaps the most effective crop is maize, which is sown late, thoroughly hoed in its early stages, and later, owing to its great height and close growth, casts a dense shade on all ordinary weeds Other crops which are useful in this way are vetches, lucerne, sainfoin, rye, and buckwheat

Tarred Paper.—In reference to the foregoing plan, the principle of cutting off the supply of light may be put into practice by the use of large heavy sheets of coarse tarred paper. Where the patches of a weed with an underground root system (Creeping Thistle, Bindweed, Couch, &c.) are not large, they may be covered with such paper, which should be securely fastened at the edges with pegs, and elsewhere with stones. In America this plan has been found very effective.

Feeding Off with Sheep.—A means of clearing off some weeds is afforded by the fact that sheep eat certain weeds which other stock reject On arable land a fodder crop may be fed off with the contained weeds before the latter seed, the result being a considerable improvement all round In pastures, sheep will eat such plants as Ragwort (*Senecio Jacobæa*), Knapweed (*Centaurea nigra*), and Ox-eye Daisy (*Chrysanthemum Leucanthemum*), especially in the young stages Indeed, feeding off with sheep is considered the best way to eradicate Ragwort in Great Britain

Destruction of Seed Screenings.—All the 'waste' seed or screenings from the thrashing and winnowing of seed crops should be thoroughly ground up or steamed before being fed to stock or otherwise disposed of They should never be thrown on the manure or refuse heap, or they are certain to be returned to the land That grinding is effective was shown by Korsmos's experiments, mill screenings containing 25 to 47 per cent of weed seeds being ground; examination showed only one weed capable of germinating in 3½ oz. of the ground screenings.

It may be added that no farmer should permit a thrashing machine to come on to his farm without assuring himself that it has been thoroughly cleaned, or many weeds may be introduced in this way

Collection of Weed Seeds at Harvest.—A point which is often overlooked is the question of destroying weed seeds at harvest time Many weed seeds ripen about the time corn is cut, and are shaken out in the process of harvesting A box attachment may be used with the reaper, being placed behind the pan with the object of catching the weed seeds, which would otherwise be swept on to the soil An arrangement might also be adapted in the case of the binder with the same object All carts and wagons should have sound bottoms and be capable of retaining seeds which may be trodden and shaken out, these being cleared out and destroyed after each day's carting

Prizes for Collecting Weeds.—It has been suggested that a useful method of aiding in the destruction of weeds lies in offering prizes for their collection by hand In Victoria, prizes were offered to school children by a police magistrate at some (then) recent prosecutions under the Thistle Act, and 12,000 plants of Ragwort were brought in during the first four days, the number quickly rising to 20,000 plants Prizes might be offered by farmers' clubs, chambers of agriculture, show committees, and so forth, for the largest collection of a specified weed in a given district, the results would probably have a far-reaching effect

Irrigation In the case of some weeds, irrigation has been found a useful medium for reducing the percentage of weeds present Over fifty years ago, for example, Buckman found at Cirencester that irrigation of a meadow much increased

a number of the better grasses, while some weeds disappeared and others were reduced, the result being that the field was 'trebled in value in four years'. Quaking Grass (*Briza media*), Hassock Grass (*Aira cæspitosa*), Bulbous Buttercup (*Ranunculus bulbosus*), and Broad-leaved Plantain (*Plantago media*) all disappeared in four years, while Ribwort Plantain (*Plantago lanceolata*) was only one-third as plentiful after the same period On the other hand, Marsh Bent Grass (*Agrostis stolonifera*) and Meadow Barley Grass (*Hordeum pratense*) much increased Where it has been possible to irrigate with spring water, the plan is said to have been adopted with complete success in clearing ground of bracken or 'fern', though in other cases a failure

Spraying —The plan of spraying weeds with chemical substances appears to have originated in France about the year 1896, M Bonnet discovering that a solution of copper sulphate destroyed Charlock without damage to the cereal among which it grew At about the same time Bolley commenced systematic experiments in the United States of America, and has done much valuable work in relation to the destruction of weeds by spraying. Considering first the possible damage to the cultivated crop, it would seem to be generally true that the cereals wheat, oats, and barley, as well as beans, peas, tares, clovers or 'seeds', sainfoin and mangolds, may be safely sprayed with a solution of pure copper sulphate –say a 4-per-cent solution. At the same time it will be as well to remark that the evidence is a little conflicting Experiments at the Yorkshire College, Leeds, showed that a 12-per-cent solution of iron sulphate only slightly damaged peas, beans, carrots, onions, beet, parsnips, mangolds, swedes or turnips, the two last, however, must be dealt with very carefully, since they are so closely related to Charlock, which is easily destroyed. (As regards the destruction of Charlock (*Sinapis arvensis*) by spraying, reference may be made to the special article on MUSTARD WEEDS)

Rough and broad-leaved plants are more generally damaged by spray fluids than smooth or narrow-leaved ones, as they appear to retain the solution, while the latter more easily throw it off Bolley found that flower parts, and parts of plants covered with 'bloom' or waxy coatings, are more or less protected, and this has been observed elsewhere. The same investigator observed that succulent and slow-growing plants are more easily destroyed by sprays than others, that plants with hairy surfaces are more readily killed than 'smooth' plants; that chemicals act differently on plants of different families, even though the plants be wetted equally readily— Charlock and Dandelions, for example, are easily damaged by a copper sulphate solution, while Creeping Thistle and clover are slowly attacked; and that most chemicals experimented with quickly destroy the tissues of any plant where the surface is broken.

Many weeds are either destroyed or largely crippled by solutions of copper sulphate, while common salt, sodium arsenite, corrosive sublimate, carbolic acid, liver of sulphur, nitrate of soda, sulphate of ammonia, chloride of potassium, and kerosene have all been used with success against various weeds Sodium arsenite and corrosive sublimate, however, should rarely be used for weed destruction unless it be on gravel and similar paths, or occasionally on land unoccupied by a crop—*e.g.* fallow land.

In Frank's experiments in Germany, tests with the sulphates of copper and iron in relation to thirty-five weeds showed that in addition to Charlock, sulphate of iron more or less damaged Corn Cockle, Poppy, Sow-thistle, Cornflower, Field Thistle, Groundsel, and Dandelion; while a 5-per-cent solution of copper sulphate (70 gal. per acre) more or less damaged Spurrey, Groundsel, and Black Bindweed Though rarely quite destroyed, these plants are so injured as to be prevented from producing seed

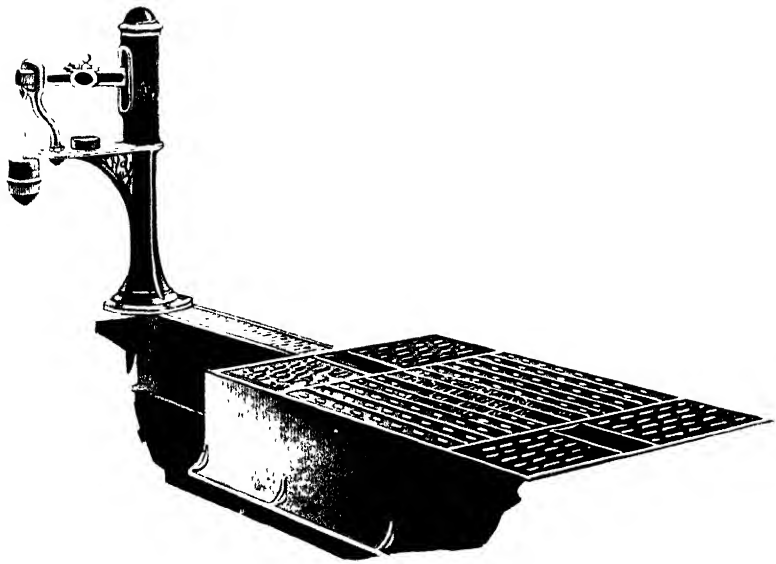
Bolley has found that the use of chemical sprays is effective in eradicating or largely subduing Charlock, Shepherd's Purse, Corn Cockle, Chickweed, Dandelion, Creeping Thistle, Bindweed, and Plantain.

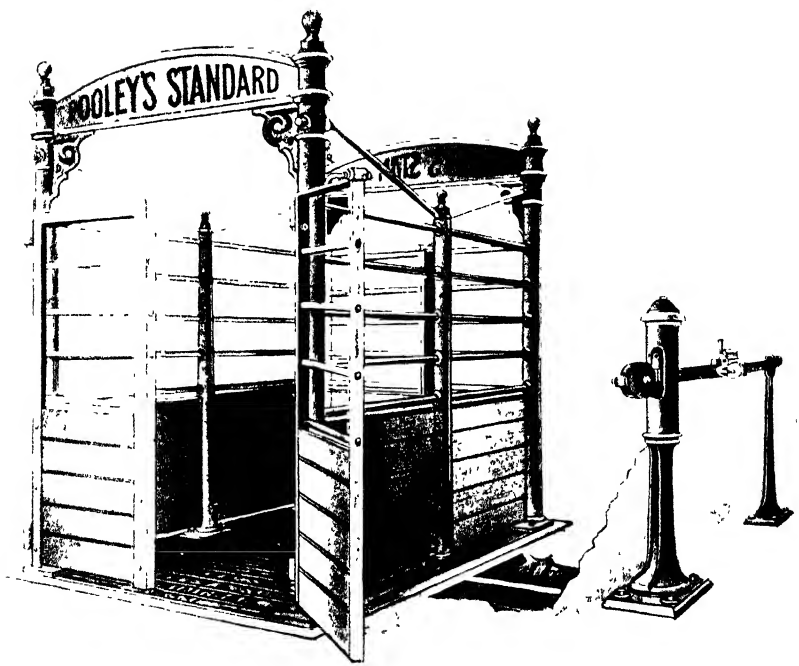
It may be definitely stated that experiment has shown that the following weeds may be destroyed by a 3- to 5-per-cent solution of copper sulphate (98 per cent pure) Charlock, Runch, Spurrey, and Redshank or Persicaria, while 2- to 5-per-cent solutions (40 to 50 gal per acre) of copper sulphate, or a 15-per-cent solution of iron sulphate (40 to 70 gal. per acre), are partially effective against Docks, Dandelion, Poppy, Perennial Sow-thistle, Groundsel, Corn Cockle, Cornflower, Black Bindweed, Dodder, Thistles, and Coltsfoot The Wild Onion (*Allium vineale*) is much damaged by a 5-per-cent solution of pure carbolic acid. It was stated in The Times ten years ago that a 15- to 40-per-cent solution of nitrate of soda and sulphate of ammonia caused young Charlock in the 'rough leaf' to wither in a couple of hours: the nitrogenous manure calcium cyanamide has been found useful for destroying Charlock in cereal crops, at the Woburn Experimental Fruit Farm it was found that Poppy, Teasel, and Wild Strawberry were practically killed by petrol, and in Germany a 15-per-cent solution of kainit has been found practically to destroy Stinging Nettles in grassland, the young growing shoots dying and allowing the grass to obtain the mastery, so that after hay harvest even the rootstocks were black and commencing to die It has been remarked that spraying of cereals has an additional beneficial effect in destroying fungi

The spraying machine for use against weeds should be as simple and rigid in construction as possible; parts in contact with the solutions should be of wood, rubber, or brass; a gauge should show that the pressure at the nozzle does not fall below 100 lb. per square inch; the barrel or tank should hold at least 50 gal., to cover an acre (or nearly) without stopping to refill, the wheels should have wide tyres.

[H. C. L.]

Weevils, a group of insects belonging to the nat. ord Coleoptera and to the family Curculionidæ The distinctive features of this group are: the head is lengthened out into a proboscis





CATTLE WEIGHBRIDGE
With Patent Stockyard and Standard Cattle Pen
(Henry Pooley & Son Limited)

or rostrum, the mandibles being found at the end of the proboscis and the eyes at the base; the palpi are small and nearly always concealed in the mouth; the labrum is absent; the antennæ in the majority of species are elbowed, thickened at the tip, and carried at the fore-end, middle, or hind part of the rostrum; the legs are four-jointed The most destructive species in agriculture are Apple Weevil (*Anthonomus pomorum*), Turnip Gall Weevil (*Centorhynchus sulcicollis*), Corn Weevil (*Calandra granaria*), Bean and Pea Seed Weevils (*Bruchus rufimanus* and *B. pisi*), Pea Weevil (*Sitones lineatus*), Raspberry Weevil (*Otiorhynchus picipes*), Nut Weevil (*Balaninus nucum*). See descriptions of these under their technical designations. [R. H. L.]

Weighbridge, a weighing machine of large size, generally set in the ground at surface level, allowing carts to be drawn upon it, or cattle to walk readily on to it to be weighed The weighbridge has attracted more attention since some twenty-five or thirty years ago Mr Westley Richards started a campaign to induce farmers to use it to obtain an accurate weight of live stock, so that the guesswork on which they had previously relied might be superseded by more exact knowledge To be valuable, live weight had to be translated into dead weight, and as a result of their tests Messrs. Lawes and Gilbert, Mr. M'Jannet, Mr Jolly, and others published records by which this might readily be approximated Block tests at agricultural shows were also instituted to pit the machine against farmers' and graziers' estimates, and the value of the weighbridge was proved. Powers were given for the erection of weighbridges in Corporation sale yards, and they have been provided in some private sale yards In some districts the weighbridge is much appreciated, and in others but little regarded, though there is no doubt that it supplies valuable information but custom is difficult to overrule The weighbridge on the farm should be big enough to take a loaded cart or wagon, so that the weight of all things purchased may be verified; and a convenient fencing should surround it to retain animals to be weighed Weighbridges are made with self-recording weighers where the weights are stamped, or may be fitted with an ordinary steelyard indicator When used in auction yards it is customary for a dial attachment to be supplied, so that purchasers may read the weights of the animals whilst on the bridge. [W. J. M.]

Weighing Machines are required for many purposes, ranging between the needs of the dairy where butter has to be weighed by the pound or half-pound, to the cattle weighbridge which may be capable of weighing several tons. The lighter machines are known as scales, and are equal-arm balances from the cross beam of which is suspended at one end the weight pan and at the other a pan, scoop, or other convenient receptacle to hold the material to be weighed Dead weights are used, and are placed in the weight pan as required. The cross beam is carried on knife-edged bearings, and has an indicator, usually on its upper side at the centre, which shows readily when a complete balance is effected; but the design may vary considerably. The largest scales used on the farm, as a rule, are those employed for wool weighing. Sack-weighing machines are of simple construction, to be used on the balance principle with dead weights. A stationary standard is placed between the balancing sack platform and the weight pan or plate For general purposes now, platform weighing machines with steelyard arms are more generally used; proportionate weights are used to give the major weights, and a small sliding weight working along the notched steelyard indicates the minor weights. In some machines loose weights are entirely dispensed with,

Equal-balance Sack weighing Machine

sliding weights being run along the steelyard, with two or more graduations, indicating tons, cwt, pounds, or such other weights as are required Weighbridges for weighing carts are sunk to ground level, and in practice it is objectionable to use sizes which do not conveniently provide room for the cart to stand on the platform and at the same time allow the load to be easily balanced On farms it is not usually necessary to use weighing machines capable of holding the horse and cart, unless it is desired to use them also for weighing a number of cattle at home [W. J. M.]

Weights and Measures.—The complexity of British weights and measures, especially of those which relate to agriculture or agricultural produce, has been the subject of legislation in every period of English history. From the days of King Edgar to those of King Edward VII, attempts have been made to secure uniformity by law, and the matter has been considered of sufficient importance to deserve a place in such momentous constitutional enactments as Magna Charta and the Act of Union between England and Scotland. From time to time an outcry has been raised at the disregard of these laws, and then Royal Commissions and Select Committees of the two Houses of Parliament have investigated the question, and have issued a multitude of recommendations. In recent times, societies have been created for the purpose of introducing certain reforms. Both Royal

Commissions and unofficial organizations have met with a qualified success. The former have succeeded in securing the passage of laws rendering not a few customary weights and measures illegal, the latter in legalizing several weights and measures which are not customary. And in spite of all the turmoil the agricultural community has continued to use such terms in the conduct of its business as are found convenient, whether legal or not, and to make such changes as were found advantageous without troubling to get parliamentary sanction. The weights and measures in common use therefore derive their sanction rather from custom than law, and their complexity is far more apparent than real, except in so far as the pedantry of schoolmasters has contrived to make it so. The real error has been in the attempt to reduce them to a system. Words, says Bacon, are the counters of wise men and the money of fools. Weights and measures may in the same way be said to be the counters of traders and the money of schoolmasters. They were devised, not to test the cunning of children in solving useless and bewildering problems, but to enable men of business to transact their affairs in the way most suited to their trade. Such complexity as has arisen in the course of years is due mainly to three causes. There are anomalies due to national and local history; there are variations from the standard due to the requirements of trade convenience; and there are purely artificial complications due to modern legislation generally inspired by a desire for international uniformity. A few irregularities have been caused by the imperfections of ancient standards, which have been discovered by the more accurate methods of modern times, but these are unimportant, and rather of historical than economic interest. The very exact measures observed in fixing the standards of the Board of Trade are seldom complied with in ordinary commercial dealings. Some perplexity has arisen from the use of local expressions, which like dialect words in a language are only understood in certain places, but these are either becoming obsolete or are in process of general adoption.

The anomalies due to national and local history are easily explained. The United Kingdom, as its name implies, is a combination of three sovereign states, each of which was originally composed of two or more sub-kingdoms. Thus in England we find certain measurements peculiar to East Anglia, others to Cornwall, others to Lancashire and the adjoining counties, as well as those which are confined to Wales. Scotland had formerly a complete system, wholly distinct from the English, traces of which are still found. In the Orkneys and Shetlands an entirely different reckoning was in use in the 18th century for local trade. It was of Norwegian origin, and was made in marks, setteens or lyspunds, merls on the malt poundlar, and chalders or lasts. There are several standards which are peculiar to Ireland. We can almost tell which parts of the kingdom were settled by the English, the Danes, or the Celts by the local weights and measures still in use. The variations from the standard due to trade convenience are of a much more abstruse and difficult character. Sometimes more than the authorized unit is given, sometimes less. Sometimes it is clear that of two standards, one a fraction of the other, one has been altered, but it is not possible to say which. Sometimes the meaning of a term has insensibly been altered till its original significance has been lost. But in nearly every case we can ascertain the cause of the change by discovering the article which was generally weighed or measured by the term under examination, and observing its liability to destruction in handling, its capacity for absorbing water, or the amount of useless material included in the purchase. As examples of a case where more is given owing to a natural liability to waste, may be quoted the well known 'baker's dozen' which contains thirteen, the 'clad score' of sheep which contains twenty-one, and the ton of various perishable articles, such as salt, which contains 21 or 22 cwt. As examples of a case where less is given owing to the inclusion of useless offal, may be quoted the 'butcher's stone', which contains 8 lb. only, and the standard hundredweight, which though obviously originally of 120 lb., *i.e.* the old long hundred, has for many centuries contained only 112. The truss of old hay comprises only 56 lb., while the truss of new hay weighs 60 lb. because the latter contains more moisture than the former. As an instance of a case where the standard has been altered we may take the quarter of wheat, which is not, as its name might imply, a fourth part of a load, but a fifth, though it is no longer possible to ascertain whether the 'quarter' has been made smaller or the load bigger to account for the difference. As an illustration of the last variation mentioned we may take the expression 'bushel', which though originally a measure of capacity, has within quite recent times become a weight, at any rate so far as the sale of wheat is concerned. Of course it is still habitually used in its proper sense in many transactions. Other instances will be given in this article. The purely artificial complications alluded to above as the third cause of complexity embrace the metrical system, which is seldom, however, employed, the cental of wheat, a measure used in Liverpool, and the method of measuring by Gunter's chain.

In the course of this article an attempt has been made to say whether certain terms are still in use or not, but it must be understood that, except in certain cases, this can only be asserted with great diffidence. Changes are perpetually taking place, and local expressions, like words in a dialect, drop out and vanish as the *national* feeling of unity strengthens. The nation thrives at the expense of the locality.

It will be convenient next to take some of the simple commercial transactions associated with agriculture and investigate the weights and measures commonly connected with each. (1) In *linear* measurements there is but little to explain, since the inch, the foot, the yard, and the mile, which are authorized units, are commonly employed in their accepted sense. The ancient Scotch inch and foot were slightly

longer than the English equivalent, but it is believed that these have entirely disappeared. The Scotch ell is probably as little used as the English. The former contained a trifle over 37 English inches, the latter 45. For measuring certain kinds of agricultural operations, however, a unit of distance, called a rod in some places, and a pole or a perch in others, is used. Forty of these go to a furlong, which is equal to an eighth part of a mile. As this is used for computing length in hedging, ditching, draining, the term implies a certain breadth, and is therefore not strictly a linear measure. A rod of brickwork indeed is the equivalent of 272·25 sq. ft. The Cheshire rod, however, is 8 yd. long instead of 5½. The 'woodland' pole is 6 yd., and in Ireland the 'plantation' pole of 7 yd. is used. In Scotland one of the old national terms—the 'fall', of nearly 18½ ft.—is not yet obsolete. In surveying land a system invented by Gunter, an English mathematician of the 17th century, is employed. It falls within the third category given above, but is based on the English furlong, or eighth part of a mile. Ten 'chains make a furlong, and 100 'links' a chain. Ten square chains or 100,000 square links equal an acre, and thus the ancient units are preserved, with the added advantage of the decimal system (2). In *square* measure the acre is the only special term, and it is universally adopted, though of course square yards, feet, and inches are used for small computations. It is divisible into 4 'roods', but measurements are usually made in fractions of the acre, which is the amount which a man can conveniently plough in a day. There are, however, a large number of local customary acres, some of which are still in use occasionally. The Leicestershire acre, the Herefordshire acre, the Wilts and Dorset acre, the Devonshire acre, are all below the standard, while the Cornish acre, and those that bear the names of the Lancashire, the Northumberland, the Westmorland, the West Derby, and the Cheshire, are all larger than the imperial acre. The Cheshire acre of 10,240 square yards is in common use in North Cheshire and South Lancashire. There are two acres associated with Wales, both smaller than the proper English acre, and an acre known as the 'woodland' which is larger. The standard Scotch acre being based on the Scotch square ell, is about the size of a standard English acre and a quarter. There is also an Irish plantation acre which is rather more than a standard English acre and a half. These are all derived from old national or local standards, but the hop acre is purely a matter of local convenience. As used on hop gardens the term implies a thousand hills, and about one and a half go to the statute acre. Other terms which are now entirely obsolete are the oxgang of 15 ac., and the '*orse-skin*' which Arthur Young found so bewildering when attempting to study the agriculture of Lincolnshire. The word is merely a corruption of 'horsegang', and, as Arthur Young found, it generally contains 9 ac., 'but varies'. It must be noted, however, that in certain counties of the Midlands the word 'acre' implies a measure of length. In Nottinghamshire it sometimes implies 28 yd., sometimes 22 yd. In Leicestershire it means sometimes 24 yd. and sometimes 32 yd. In Lincolnshire an 'acre length' means 40 poles, an acre breadth 4 poles.

We come next to measures of capacity, and begin with *liquid* measure. Even in Magna Charta it was recognized that the measures for wine and ale were different, though it was fondly hoped that it could be ordered successfully that there should be but one measure for each throughout the kingdom. The standard unit is in all cases the gallon, containing 4 qt. or 8 pt. The pint is divided into 4 gills or noggins, but in Yorkshire and Lancashire the gill by custom equals half a pint. Thirty-six gallons of ale or beer go to a barrel, but except in transactions relating to beer the gallon is always used, and the 'barrel' is now little more than the equivalent of a cask. It may be noted in passing that this custom is not confined to agriculture solely, and that engineers always reckon in gallons even when dealing with very large volumes of water. The gallon, however, has not always been of the same capacity. As recently as 1890 the Board of Trade decided that the gallon should contain 277·463 cub. in., or 10 lb. of distilled water at 62° F., and with the barometer at 30 in. The old capacity was 277·274 cub. in. The Scotch gallon, now obsolete, contained a trifle over 3 imperial gal., and an Irish gallon a trifle over 3 qt. The Scotch measures, a mutchkin and a chopin, containing a quarter and a half of a Scotch gallon respectively, are no longer in use, except possibly as colloquial terms. In England certain liquors were sold by the 'reputed pint', but these were not strictly speaking British agricultural products. An anomalous and illegal measure known as the 'barn gallon' is, however, in common use in the milk trade, in which connection it has recently been the cause of much complaint. Although used in many parts of the country, it is only in connection with the sale of milk for London. In Manchester the unit for milk contracts is a 'dozen', *i.e.* 12 qt. or 3 gal. The origin of this measure is stated to be as follows. 'The milk used in the metropolis was formerly all produced within its borders, or in the immediate neighbourhood, but the production of milk and the distribution of it were then as now quite distinct and in separate hands. The milk was produced in large sheds, or barns as they were called, where as many as 200 or 300 cows were often kept tied up. These cows were all milked by the retailers or distributors of the milk, and this for two reasons. In the first place it saved the cowkeepers the expense of keeping the large staff of men necessary to milk so many cows, and in the second place the retailer was quite sure if he milked it himself that he got it genuine. In those days, if the milk was lost sight of for ever so short a space of time it was invariably watered. The retailers having milked it themselves, the next thing was to take it to the measuring room, where the owner or his manager stood waiting to measure it. This was done by the purchaser holding a gallon measure, which was filled twice until it ran over freely. This was called the

barn gallon, and was usually about 9 qt. to the gallon. When the country milk trade began, farmers in the absence of the purchaser did not run the measure over quite so freely, and many disputes used to arise, until at last both parties accepted 17 pt. as the standard measure.' The railway milk churn in common use in the south of England contains 17 imperial gal. or 8 barn gal. On the other hand, it must be remembered that in the retail trade a barn gallon contains only 16 pt.; and the advertisements of businesses for sale with a trade of so many barn gallons per day refer to the term as used in the retail and not the wholesale trade. A Cumberland gallon, however, which contained 2 imperial gal., was in use recently and is probably not extinct.

After all, by far the greater part of a farmer's wares consist of such annual or vegetable produce as can only be sold by dry measure, or by tale if it is not sold by weight; and the systems in vogue in such dealings deserve the closest attention, especially in the case of the sales of vegetable produce, where the greatest diversity prevails in practice. Wheat, barley, oats, hay, straw, fruit and vegetables for human consumption, are sold by measure in one place and by weight in another, or in some cases by measure at one season of the year and by weight at another. Sometimes, as has already been stated, the terms used properly denote a measure, but by custom and in practice imply a certain weight. It is very largely due to this cause that British weights and measures have incurred the charges of perplexity and confusion that have been brought against them. But the influences which have brought about this diversity are simple and inherent to the trade. In the first place, all produce whose price varies according to its quality tends to be sold by measure, and all produce whose quality is more or less uniform is sold by weight. Small quantities of the best and earliest crops are put on the market sometimes in specially prepared packages and fetch a special price, while the main bulk of the harvest is afterwards sold according to a more or less ascertained standard. Occasionally it happens that sales under each condition take place simultaneously As an illustration of the former case the sale of wheat and barley may be quoted. As is well known, the sale of wheat, which was formerly conducted in terms of measure in practically every instance, is now nearly everywhere carried out by weight. The Corn Returns Act of 1882, which requires all sales of wheat, barley, and oats in certain scheduled English markets to be recorded in terms of the imperial bushel, and enacts that sales by weight shall be transmuted according to a fixed standard, has helped to perpetuate the older system; while the introduction of foreign corn, which is sold by the international system of weight, has tended to break it down. The latter influence has so far prevailed that in Liverpool wheat is sold by the cental of 100 lb., and the advocates of that method have endeavoured to enforce it throughout the country, at present without success. But though the cental has not proved popular generally, there are many places where wheat is sold by weight, and in recent years there have been many proposals in Parliament and elsewhere to make this method compulsory. The agitation has met with fierce opposition from the barley growers of Norfolk, who contend that this would be disadvantageous to them The best barley, such as is grown by them for the high-class brewers, is thin-skinned and light, and its quality is always associated with these attributes. Not only therefore do buyers of this barley never ask what the weight is, but the lighter qualities actually sell at a higher price than the heavy varieties, owing to their better colour. If this barley were sold by weight there would be a risk, so it has been asserted, that the purchasers would demand that the grain should be made up to a given weight, as is done in the case of wheat. Of course this only applies to malting barley, since grinding barley is always sold by weight Another example illustrative of the practice of selling the choicest samples by measure and the commoner sorts by weight may be taken from the sale of early vegetables. The first peas that come on the market are sold by the peck; later on, peas are sold by the pound The earliest strawberries are sold by the punnet, and other fruit is sold under analogous terms, but when the season is in full swing they are sold by the pound Besides these influences, which may be called natural, there are other influences at work which affect the development of trade relations These are the legislature and the railway companies Parliament has in certain cases stept in, avowedly to prevent fraud, and has insisted that hops shall be sold by the pocket, and that hay and straw shall be sold by the truss in London; and in these instances a certain amount of success has attended the efforts of legislators. The railway companies, on the other hand, for obvious reasons, endeavour to make each consignment of equal bulk weigh an equal amount, and have issued a scale of charges for fruit and vegetables according to an assumed weight. It is probable, therefore, that in the near future all measured consignments will conform to the reckoning of the scales and the weighbridge

In view of the facts just narrated, it will be seen that it is not always easy to say, when certain terms are used, whether a true measure or a true weight is implied, and it will be better to deal with the tables known as avoirdupois and dry measure together The first, as its title betokens, is considered to be of foreign origin; that is to say, it was introduced into this country by foreign merchants, and at a later date than the old Troy weight. It has, however, for some centuries become embodied in English custom, and has undergone changes characteristic of English trading methods. The true units are the ounce, the pound, and the ton, whereof 16 oz. go to the pound, and 2240 lb. to the ton Two additional units have, however, been introduced, viz. the stone of 14 lb., and the hundredweight of 112 lb. The quarter of 28 lb. is of course merely the fourth part of a hundredweight According to this calculation 20 cwt. go to a ton, and this is the usual reckoning.

But it is clear that the hundredweight of 112 lb is not the original weight, and it is obvious that some process of degeneration must have set in, for the hundredweight must have originally been the 'long hundred' of six score or 120 lb., which is no convenient fraction of the ton of 2240 lb. Be this as it may, the pound has not always been a uniform weight In the Lake District, where it was known as the long pound, it equalled 22 oz. A similar weight prevailed in parts of Durham, but in some parts of the county it contained 21 oz., and in others 24 In Yorkshire the pound usually contained anything between 16 and 24 oz. In Cheshire, Lincolnshire, Herefordshire, Gloucestershire Dorset, Devon, and Cornwall it generally contained 18 oz.; in Shropshire, Buckinghamshire, and other counties, generally 17 oz. These variations, which were customary chiefly as regards the sale of butter, no doubt have their origin in the exceedingly watery state of the butter made by the farmers, which, before it had long been in the hands of the purchaser or consumer, shrank and lost weight by as much as one or two or even more ounces in the pound. But in Scotland the pound seems to have weighed more than 16 oz. even where other kinds of foods were sold Thus in Banff, butter, cheese, hay, and wool were sold by the pound of 24 oz, while meat and meal were bought by the pound of 17½ oz In Aberdeen, for butter and cheese the pound contained 20 or 26 oz.; for meal, malt, and corn, 24 At Brechin, Forfar, and Montrose it held 24 oz , at Glamis 26, and at Kirriemuir 27. At Perth there were 22 oz : at Campbeltown 16 oz , at Inveraray 24 oz ; at Dumbarton 23 oz in the pound. At Ayr, for butter, hay, and meat, 24 oz In East Lothian, for hay, hides, and tallow, 22 oz At Berwick, for butter, 18 oz , but in the country markets of the county 22½ oz , which was also the usual pound for cheese. At Peebles, for butter, cheese, hay, and wool, 23 oz , at Wigtown, 16 or 24 oz. for butter In Kirkcudbright in many parishes the pound consisted of 28 oz, in many others only 26 In Roxburgh 21 oz These are only some of the various forms which the pound was liable to take Somewhat similar changes beset the stone. In many parts of the north of England the stone instead of weighing 14 lb. held 16 lb. In South Wales 12 lb. In most parts of the south of England it consisted of 8 lb. only, a practice which still prevails in London, as has already been stated. It is indeed only recently that the change was made to the standard of 14 lb. in one very important Yorkshire town, to the great regret of an intelligent butcher, who informed the writer that he preferred the older system, since a rise or fall of a farthing a pound meant a corresponding change of fourpence a stone, a computation which lent itself more easily to rapid calculation than the authorized system. In Scotland, again, the stone underwent many changes. In Aberdeenshire, for meat, butter, cheese, tallow, it held 28 lb. as a rule, but in some places 26 lb., and in others 22 lb. In Argyll 24 lb.; in Ayrshire the same; in Banffshire 24 or 22 lb. In Berwickshire no less than five stones were used, consisting of 23 lb., 24 lb., 23 lb. 8 oz., 21 lb. 14 oz. and 16 oz respectively. In Bute and Caithness there were 24 lb to the stone; in Dumbartonshire 23 lb. and 16 lb. of 23 oz ; in Inverness 24 lb.; in Kincardine 16 lb. and 20 lb.; in Kirkcudbright 17½ lb , in Lanark 22 lb.; in Peebles 23 lb., at Tain, in Ross-shire, 22 lb., in Roxburghshire 24 lb , 23 lb , and 24 lb. 2 oz., in Selkirk 17 lb. 8 oz and 23 lb. 8 oz ; in Stirlingshire 20 lb. 1 oz , in Sutherland 24 lb ; in Wigtownshire 26½ lb These reckonings are all for butter, cheese, tallow, butcher meat, and other similar goods, and do not include the large number of other variations which are found in connection with the sale of wool Even the hundredweight itself occasionally varies and while in Cheshire it formerly always stood for 120 lb. in the sale of cheese, and still does so in some places no doubt, in Lancashire it was used to imply 106 lb , 112 lb., and 120 lb Elsewhere it is said to weigh 121 lb. But traces of the old notation remain in the use of the expression a 'score' or 20 lb , i.e. one-sixth part of the old long hundred, and of the 'pack' of 240 lb., which is still in common use in many places in the north of England For measures of capacity the units are the bushel and the quarter. The latter was prescribed under the name of the London quarter as the sole legal measure for corn by the 35th article of Magna Charta, and has been in common use ever since, but is being ousted from its position by the bushel, which, as already stated, in many cases denotes a weight The quarter is supposed to contain 8 bus. and the bushel 4 pk But local variations are occasionally met with. Thus in Northumberland a peck amounts to one-third of a Winchester bushel, while a Craven peck is equal to half that measure. In South Wales and North Gloucestershire there are 20 qt instead of 8 to a peck In Scotland the peck contains about three-eighths of a Winchester bushel, and other varieties are found. These are, however, as nothing compared with the forms in which the bushel has from time to time appeared. The standard bushel is 1 28 cub. ft in size, with a diameter of 19½ in and a depth of 8¼ in. The Winchester bushel, which was for many years the measure most often used, contains 2150 4 cub. in., and equals 9688 of an imperial bushel. It was carried across the Atlantic by the English emigrants, and is the standard bushel in the United States. The imperial bushel contains 8 gal , but there are several provincial bushels in use. The Carlisle bushel, for instance, contains 24 gal., and this is used in many parts of south-west Scotland. But at Penrith a bushel of barley, oats, or potatoes contains 20 gal., and of rye or wheat 16 gal. The Cornish bushel also equals 24 gal., while the Appleby bushel holds 2 imperial bus. In Staffordshire the bushel holds 9½ gal. In Lincolnshire 4 bus go to a quarter of wheat. In Leicestershire 8½ or 9 gal. make a bushel. In Worcestershire the same sizes are found. In Shropshire the bushel holds 9½ or 10 gal. In parts of central Wales 20 gal., in others 10 gal The latter measure is also found in Herefordshire and Berkshire, but in Gloucestershire it is generally 9½, though at times 9, 9¼, and 10 gal. In Oxfordshire 9 gal.

3 pt In Sussex and Dorset 9 gal The word is seldom used in Scotland, except in the authorized sense, but in Ayrshire the bushel is said to contain 2 pk. only. It may be as well to record at this point that a bushel is often called a strike, but there are many exceptions to this practice. Sometimes it means half a bushel only; at other places it means an exact bushel, that is, all that is contained in the measure after the surplus has been 'struck' off. In Cornwall it is said to equal a Winchester bushel, or one-third of a Cornish bushel According to one authority it may even contain as much as 4 standard bus

In Scotland, however, an entirely different scale of measures prevails, based on the old Scotch customary measures; and these, though no longer legal, are in common use not only in the northern kingdom, but in many parts of the north of England as well The terms are the lippie or forpet, the firlot, and the boll, which contained 4 firlots and 64 lippies The smallest measure contained about 0·932 of a Winchester bushel, or nearly a quarter and a half of an English peck. The term is still used, but is becoming obsolete, and is now generally used figuratively to imply a small extra allowance Forpet means originally fourth part, and equals a quarter of a peck, but in some parts of Northumberland 5 forpets equal a peck. The firlot, again, is derived from two old Norse words meaning fourth part, but in the West Riding of Yorkshire it required 8 firlots at one time to make a bushel In some parts of Scotland it was as much as 1½ Winchester bushels for certain articles, and about a tenth more than such a bushel for others The boll was perhaps even more diversified. To begin with, there were two standard Scotch bolls the first, for wheat, pease, beans, rye, and white salt, was raised from the standard firlot containing 21¼ pt., the second, for oats, barley, and malt, was raised from the standard firlot containing 31 pt Bolls varied in practically every county in Scotland, and often in two or three places in the same county; but in every case the boll for oats was larger than the ordinary standard. In general terms this is due to the varying quantity of moisture in the oats that were sold, and the qualty of the grain. Thus in Elgin and Inverness the boll of oats varied from 5 to 8 firlots according to the quality of the grain, 'the idea of a boll of oats being', as one authority says, 'what will produce a boll of meal, so that in some places where the grain is good, 18 or 19 pk will make a boll'. The Scotch standard boll for wheat was equal to a little more than 4 Winchester bus., the boll for oats to nearly 6 such measures But in Aberdeenshire the wheat boll equalled about 5 bus. and the oat boll a little over 6 In Argyllshire the common boll held 4¼ bus., the oat boll 6¼, except at Campbeltown, where it held 7¾. In Ayrshire the wheat boll held 4½ bus. and the oat boll 6½, but in calculating ministers' stipends 7½. In Berwickshire the wheat boll was 6¼ bus., and in the sale of wheat and barley another boll was added in each score. The Langholm boll used in Dumfriesshire and in Eskdale contained no less than 12½ Winchester bus., while the Moffat boll used in the upper part of Annandale held 13¾, and the Annan boll held 9¾. In Kirkcudbright the oat boll held in theory 10¼ bus., but in practice 11 Winchester bus. were always given In Wigtownshire the wheat boll equalled the English quarter, and the oat boll held 4 bus. more. In England the bolls were never so various, but the wheat boll in Hexham contained 4 Winchester bus., while in other places the boll held but 2. The oat boll at Hexham held 5 bus. and at Alnwick 6 bus. In addition to these local measures it must be remembered that a boll was often held to imply a weight, as in Elgin, where meal was sold by the boll of 9 st., and salt by the boll of 2 cwt., and that in some cases the bolls were 'striked' and in others heaped

These weights and measures were all variations from the legal standard, which were tiresome and difficult to grasp because the authorized terms were used in some other than their accepted meaning But there were, and are still in many places, expressions used which had no other than a customary sanction Thus, in the West of England, wheat and other articles are sold by the bag, generally equivalent to 3 bus, but in Devonshire a bag of wheat is 2 bus or half a sack At Kingsbridge it weighs 120 and 125 lb In South Wales a bag of oats equals 7 heaped measures or 8½ strikes A speaker at a recent meeting of the Central Chamber of Agriculture asserted that in some places a bag of oats weighed 196 lb and in others 200 lb In Kent a bag of hops holds 2 cwt, while in the west country a bag of potatoes weighs 160 lb and a bag of apples or turnips 120 In north-west Devon, however, the bag of potatoes is believed to hold 140 lb. The barrel, a term always used in Ireland for the sale of wheat, is the equivalent of 20 st of 14 lb each, or 280 lb, for wheat, potatoes, beans, and pease, but for barley it holds only 16 st, for malt 12 st, for oatmeal 8 It was at one time used in Suffolk and Essex in the sale of butter In the former county it held 256 lb., in the latter 106 It is reported as containing 224 lb. elsewhere A chalder, which was a recognized measure in Scotland for wheat, held 16 bolls; but in England, where it was only a customary measure, it held 4 qr, or only about one-third of the Scotch measure. The coomb, a term invariably used in East Anglia even at the present time, holds 4 bus. or half a quarter. The gaun, a west-country expression, is the same in all respects as a gallon, of which it is merely a dialectic form The fow, a striked measure associated with the Cunningham district of Ayrshire, contained 2035·756 cub. in., and 5 fows made a boll of wheat, rye, pease, and beans, but 8 were required for a boll of oats. In Berwickshire, Forfarshire, and elsewhere in Scotland a cap of wheat was one-quarter of a peck. The auchlet was the eighth part of a boll, as its derivation implies; but it appears at one time to have contained one-sixteenth part only, in Kirkcudbright and Wigtownshire. The authority for this statement says that the auchlet is a round vessel of 18 in. in diameter within the brim, and 4 in. deep, the brim being ⅜ in. thick. It is said to contain

about 9 pt. 13 gills [sic], but by gauge it contains about half a gill more; however, in practice the boll consisting of 16 auchlets, striked measure, is reckoned equal to 8 Winchester bus. A leap or lip was an old English term for half a bushel, and has long been obsolete. A last was a measure which usually held 80 bus or 10 qr., but in many places an extra half-quarter was added in the sale of oats. A load is a more or less vague term in general use in England and Scotland, where it is sometimes called a lade. In most cases it implies merely as much as a man, or a horse, can carry, or a cart can contain, but occasionally it assumes a more or less definite size or weight. Thus the Bedford load is 5 bus., 'as much as a man can carry', and this measure is accepted in many parts of England. In Dorset, Berks, and Bucks, however, it is equal to the imperial load of 40 bus., and in some parts of the country it holds 4 or even only 3 bus. In the north of England and Scotland it implied 260 lb or 280 lb., 'the quantity sufficient to load a horse'. In Cheshire, however, according to the English Dialect Dictionary, 'a load of wheat consists of 4 measures, and varies in weight in different localities'. But taking Cheshire generally, a load of 14 scores is the most general for wheat. A load of potatoes, however, weighs 12 lb more. The hobbet, a measure used in Flint, contains $2\frac{1}{2}$ imperial bus., but the word is now used generally as a weight, and implies 168 lb of wheat, 180 of beans, 147 of barley, or 105 of oats. The kenning, a measure in use in Northumberland, holds half a bushel. Another local measure is the listed, two of which make $5\frac{1}{2}$ bus. This was in use as late as 1879 in Cardiff market for the sale of wheat. In Cheshire and in some other parts of the country the word 'measure' is used instead of bushel. Oddly enough, the word always implies a weight of some kind, but the amount varies with the article sold, and very often with the locality. A sack is often used in the same way. The word generally implies 4 bus. of wheat and 5 of oats; but in Dorset a sack holds $4\frac{1}{2}$ Winchester bus. of wheat, and in Surrey 4 bus. of oats. In Warwickshire it holds 3 bus. of 9 gal. each. In Lincolnshire it implies a weight of 18 st., that is, 252 lb. In Preston market wheat is sold by the windle, nominally a measure of 3 bus., but reckoned now always as a weight of 220 lb.

Thus there are a very large number of weights and measures by which grain of various kinds may be sold, and many of the terms employed have more than one meaning. It was said some years ago that there are a hundred and twenty different ways of selling wheat, and the number has probably been underestimated. Parliament has, however, endeavoured to introduce some degree of uniformity, by requiring that for the corn averages all weights and measures that vary from the authorized unit shall be reduced to a common standard. Section 5 of the Corn Returns Act of 1882 provides that where returns of purchases of British corn are made to the local inspector of corn returns in the markets scheduled under the Act in any other measure than the imperial bushel or by a weighed measure, the officer shall convert such returns into the imperial bushel; and in the case of weight or weighed measure the conversion is to be made at the rate of 60 imperial lb for every bushel of wheat, 50 imperial lb. for every bushel of barley, and 39 imperial lb for every bushel of oats. The numbers were chosen because it was believed that they represented the average of the natural weights of the different classes of grain sold in the markets. But in a great many towns a different standard has been adopted, and a bushel of wheat is expected to weigh more as a rule than that amount. In all these cases where the bushel is understood to imply a certain weight, corn is said to be sold by weighed measure. In many cases the weight of the bushel depends on the quality of the grain, and it is a matter of arrangement between buyer and seller to what weight the bushel or quarter shall be 'weighed up'. If 63 lb. is stipulated and the natural weight of the corn is only 62, the seller must supply 1 lb more at his expense. But in some other case the weight of the bushel or quarter is customary, and if the natural weight of the grain is more the seller gets the benefit. Thus according to Mr John Talbot's return of the weights and measures whereby wheat, barley, oats, indian corn, peas, beans, wheat flour, oatmeal, and barley meal were sold in certain markets in 1879, we learn that the bushel's weight in Banbury was 62 lb., in Barnstaple $67\frac{1}{2}$ lb in the market, but for imported wheat 62 lb. In Bath the quarter held 480 lb., in Bedale 36 st. In Bedford the bushel weighed 62 lb and 63 lb. In Bicester, Birmingham, and Bridgwater 62 lb. In Bristol, English wheat weighed 60 lb. to the imperial bushel, and foreign 62 lb. At Burton-on-Trent the bushel held 63 lb., at Cardiff 60 lb. and 61 lb.; at Cardigan 65 lb., at Carmarthen 64 lb for wheat in the market, and 62 lb for imported. In Carnarvon the quarter held 504 lb. In Chard the bushel equalled 62 lb; at Chepstow 62 lb.; at Chester 75 lb., at Chesterfield 63 lb; at Cirencester and Coventry 62 lb., at Dartford 56 lb., at Exeter 62 lb.; at Fareham 60 lb., at Gloucester and Hereford 62 lb.; at Hexham and Huntingdon 63 lb; at Ipswich and Leeds 60 to 63 lb.; at Liverpool 70 lb; at Maldon 60 lb., at Mansfield 63 lb.; at Middlewich 75 lb., at Nantwich, where it held $1\frac{1}{4}$ imperial bus., 75 lb., at Northampton 62 and 63 lb.; at Norwich 63 lb.; and at Oxford 62 lb.; at Sheffield 63 lb; at Shrewsbury 75 lb grain in the market, and 100 lb. for imported grain; at Tarporley 75 lb.; at Taunton and Tewkesbury 62 lb; at Wakefield 60 lb.; at Warrington, Wigan, and Whitby, 70 lb., at Wolverhampton 62 and 72 lb., and at Wrexham 75 lb. In Scotland the same practice prevails, though there the system has been carried to a further point. According to the evidence (Reply 319) taken by the Departmental Committee on Scottish prices, in Forfarshire no barley and oats are sold by the natural weight at all. A standard weight per bushel has been adopted, which was then 56 lb. for barley and 42 lb. for oats; but in this county, except in extraordinary seasons, neither barley nor oats reach the standard, and every farmer has to

'weigh up'. The standard has grown in living memory from 52 lb. to 53 lb., then 54 lb., and finally 56 lb., so that in the course of a few years there have been four different 'weighed bushels' in this district alone. The final result has been that the agricultural newspapers, in recording prices, have abandoned all attempts to quote local measures, and as transactions are not conducted in authorized measures the reports quote the price per quarter or other measure of so many pounds, and the statements run that wheat was sold at so much per 504 lb., per 496 lb., per 480 lb., per 470 lb., and so forth, a compromise, it is true, but one which harmonizes local custom with a method whereby comparisons may be made all over the kingdom. It may be of interest to quote some of the various standards employed. Thus in a single number of the Mark Lane Express there could be found quotations of British grain per 504 lb., per 480 lb., per 448 lb., of foreign grain per 496 lb., at Mark Lane. Foreign wheat was quoted at the Baltic per 492 lb., per 480 lb., per 500 lb.; while British wheat was quoted at the county corn markets per 186 lb. at Birmingham, Coventry, and Warwick, per 336 lb at Carlisle and Sunderland, per 75 lb. at Chester, per 62 lb at Hereford, per 504 lb at Ipswich and Newbury, per 'windle of 120 lb' at Preston, per 216 lb. at Wolverhampton. Barley was sold at Mark Lane per 448 lb., per 416 lb., per 400 lb., at the Baltic per 400 lb and per 448 lb., per 64 lb. at Chester, per 440 lb at Coventry, per 56 lb. at Hereford Oats sold at Mark Lane per 330 lb., per 312 lb., and per 304 lb. Foreign oats per 320 lb., per 4 lb at Chester, per 352 lb at Coventry, per 40 lb at Hereford, per 320 lb at Newbury, per 196 lb. at Wolverhampton Beans are quoted per 532 lb and per 504 lb. Peas per 504 lb. at Mark Lane, and per 65½ lb. at Hereford for beans and peas Other measures, such as the imperial quarter, are also given.

The sale of hay and straw is the next matter for consideration. In London, as has already been stated, the sale is regulated by an old Act of Parliament, amended by another Act passed in 1851. This law, which prescribes several rules for the market, ordains that all hay and straw shall be made up and sold in bundles or trusses which are to weigh in the case of new hay 60 lb., old hay 56 lb., and in the case of straw 36 lb. Every load of hay or straw is to contain 36 trusses. On the other hand, in the country markets hay and straw are usually sold by the standard ton or by the stone, both the imperial weight. In the country districts, however, straw was till recently, and is now on many occasions, reckoned and even sold by the bat or batten, sometimes called a loggin, or a fad, and a threave, in some places called a thrave. Generally the number of bats, loggins, or fads that make a threave is twelve, but this is when the straw has been drawn for thatching, or at any rate the grain has been threshed out. The threave is also used in connection with the straw just as it has been reaped and made up into sheaves. In this case the calculation is made a different way. A sheaf of wheat is as much as will make a bundle of a particular size, often 12 in. in diameter. Ten inches is customary for barley and oats. Fourteen of these sheaves make a stook of wheat, 12 in the case of the two other kinds of grain. Sometimes a threave is made up of 2 stooks, sometimes 14 sheaves, sometimes 12. In Northamptonshire 10 sheaves of corn make a threave, in Warwickshire 24, in Hertfordshire in the old days, according to the agricultural writer Ellis, no less than 30. In the district of England which lies near the upper Thames, that is, Gloucestershire, Worcestershire, Oxfordshire, and Wiltshire, straw is reckoned by the bolting, a term implying in different places 12 to 24 lb in weight In Herefordshire also it is used in the sense of 14 lb. The word is also used in connection with the preparation of osiers for market. Hops, though sold by the hundredweight at one time, are now generally dealt with by the pocket, a measure which has come to mean a weight of 1½ cwt., or according to one authority 1¼ cwt. in Surrey. The pocket, however, is not merely an expression, but is the actual parcel into which the hops are packed At one time hops were also sold in bags of about 2 cwt. each, but this is now practically obsolete, since only the worst hops were bagged, and for these there is now practically no sale

The sale of vegetables is conducted with the use of perhaps more peculiar terms than any other transactions in agricultural produce Many articles are of course sold by the authorized weights and measures, such as the peck, the bushel, the pound, the hundredweight, and the ton, according as the consignments are large or small But there are many local terms in use, and as vegetables differ in size, shape, and quality, so do the methods of dealing in them vary In addition to the complexity thus caused, there must be added the complexity caused by foreign fruit and vegetables, which are packed in the form customary in the country of origin, and sold under that form in England. Thus in the words of one writer, 'vegetables may be gathered and loaded direct on the wagon, cart, van, or barrow; may be secured in bundles with bass or rods, tied in bunches with rods, arranged in 'hands', packed in loads, flaskets, crates, hampers, pads, sieves, half-sieves, quarter-sieves, flats, molleys, prickles, feys, pottles, punnets, 2-cwt sacks, 1-cwt sacks, pea bags, ½-cwt bags, besides foreign bags of no defined size, and barrels, boxes, trays, of innumerable size and endless shapes'. All these are found in Covent Garden alone, while in country markets several other measures and weights are in use. It will be best to deal with these in alphabetical order, premising, however, that none of these are legal terms, and that in many cases they are not even supposed to be definite, but are merely convenient expressions for certain consignments, which are generally weighed, or at least computed, in some other way for purposes of payment Some, however, have been investigated by the officials of the Board of Agriculture and Fisheries, and the weight—approximate or actual—with which each is equivalent is published in the Weekly Returns of Market Prices, whenever

it is found necessary to quote these terms instead of the standard avoirdupois. Thus a bag of potatoes, a term used in Leeds, contains 126 lb., though according to another authority it is really a measure holding 3 bus., and is used in the sale of apples and turnips as well. It generally implies a weight at the present day, and contains 120 lb of the latter articles In Somerset, however, a bag of potatoes is 160 lb., and in Devon 140. Foreign apples are frequently sold by the barrel in all English markets. In this case the equivalent is 140 lb.; but a barrel of Nova Scotian apples weighs 126 lb. When potatoes are sold by the barrel, as is the case at Glasgow and Leeds, a hundredweight and a half is sold at the former city, and only 84 lb. at the latter Strawberries, cherries, currants, and other soft fruit are often sold by the basket According to the estimate of the Board of Agriculture a basket of cherries or currants contains 8 lb., but a basket of strawberries only 5 lb Scotch strawberries are, however, sold in Birmingham market by the basket, which contains only about 4 lb It is elsewhere recorded, however, that in South Wiltshire a basket of potatoes holds 3 pk, and that in Birmingham a basket of grapes holds 7 to 12 lb, of pears 72 lb., and of strawberries 1 gal, while in Kent a basket of cherries is said to hold 48 lb Strawberries are also dealt with under the curious reckoning of '2 boats', which are computed to be equal to 7 lb. As they are not sold by the single 'boat' it may be assumed that the phrase is corrupt A box of potatoes weighs about 64 lb, but only foreign consignments are sold by this method. The bushel, and even more frequently the 'half bushel', are used in the fruit trade The bushel of apples contains 42 lb, and the half-bushel 21 lb For pears the reckoning is the same, but in the case of cherries the contents weigh 24 lb, and in that of damsons and plums 24 lb to 28 lb. A 'case' of apples holds 40 lb, but a case of French pears usually holds 40 pears and weighs 12 to 15 lb A case of Valencia onions, on the other hand, weighs about 120 lb. French pears are, however, not always sold in this way. Sometimes they are packed in 'crates' which hold from 64 to 90 pears and weigh 18 to 20 lb English apples are occasionally sent to market in a 'flat', which contains a number equivalent to the weight of 42 lb Strawberries are at times sold by the 'gallon', an expression which, though it probably implies a measure, at any rate approximately, is computed by the Board of Agriculture to be equal to 6 lb. The 'hamper' is frequently used in transactions about apples, and is reckoned to be about 80 lb. The hamper of potatoes bought in Leeds market is of the same weight. In Liverpool currants are sometimes sold by the 'handle', which has been computed to be equal to 6 lb. The 'load' of potatoes at Manchester holds 252 lb. The 'peck' of gooseberries and strawberries is estimated at 12 lb., and fruit sold by that term are no doubt more often weighed out than measured. The next expression– the 'pot'—is more than a mere local word, and is the weight by which perhaps more fruit is sold than any except the pound and the ton. In common use it implies 63 lb. for most kinds of fruit. The Evesham pot, however, contains 64 lb of apples, 72 lb. of pears and plums, while it holds 80 lb. of potatoes. A pot of peas at Worcester market, however, holds only 40 lb. The 'round' is employed in the sale of greengages, and has been computed to hold 7 lb. The 'score' is occasionally used when dealing in potatoes. It implies 21 lb, not 20 Cherries are sold at Wolverhampton by the 'side', which is equivalent to 63 lb Finally, the sieve and half-sieve are words in common use, but with no very definite meaning According to the computation of the Board of Agriculture, a 'half-sieve' of apples and pears weighs 28 lb., but generally the sieve is taken to be the equivalent of a bushel, or in some cases 10½ imperial gallons Other authorities differ, and it is probable that originally the expression was used in a much more general way. Thus, according to one statement, a sieve of cherries in Kent contains a bushel weighing 56 lb, while another says that 2 sieves make a bushel, and that a sieve of cherries in the same county weighs 52 lb, a third says that a sieve of the same fruit is equal to about 48 lb. In addition to these terms it is recorded that fruit is sold in Glasgow by the sleek, a West of Scotland bushel, now computed at 40 lb. for apples, 50 lb for pears, and 60 lb. for plums. In Covent Garden strawberries are also sold by the pottle, a large tapering basket supposed to contain half a gallon, but seldom holding more than 1½ pt A pottle of mushrooms, however, should weigh 1 lb. The punnet is a receptacle in which fruit is often sent to market It holds 2 lb or 4 lb according to size, and varies in shape, but it is generally circular, and measures 8 in. in diameter Agricultural produce is often sold in bundles, bunches, hands, and tallies. The bundle of asparagus contains 100 to 150 heads; of celery and broccoli, 6 to 20 according to size; of seakale, 13 to 18, of rhubarb, 20 to 30 stems. A bunch of carrots holds 36 to 40, of turnips 20 to 25, while a hand of radishes varies from 12 to 30 according to the season. A tally of cabbages is 5 dozen In addition to these vague and somewhat indefinite measures, fruit and vegetables are sold by many terms, such as the dozen, the score, per dozen bunches, per 12 lb., per 36 bunches, per 100 bunches, per 20 bunches, and so forth These expressions cannot be relied upon for purposes of comparison, and can only be called measures in the most general sense.

Besides these articles there are other kinds of agricultural produce which are generally sold by standard imperial weights and measures, but occasionally by special terms. Thus wool is usually sold by the pound, but occasionally by the tod of 28 lb. In Lincolnshire, however, by custom the tod contains 28½ lb. Cheese is generally sold by the hundredweight or pound, but in the eastern counties it was at one time sold by the weigh or wey, sometimes called a weight, of 256 lb. or 336 lb. Wool was once dealt with in this manner, but the term then implied 30 lb, or sometimes 30½, 31, or 32 lb. Cider is put up in a pipe of 100 to 110 imperial gallons; hay by the bale of 2 cwt.; butter by the firkin of 56 lb. or the tub of 84 lb.; plums by the carton of 9 lb.;

and wood by the cord of 128 cub ft., the stack of 108 cub. ft., and the square of 100 ft. It is perhaps not necessary to say that even this list is not exhaustive, and there are several other terms which were once common and are still perhaps occasionally used, though they are fast disappearing. But a much longer treatise than the present article would be required to deal with every term used, and to treat the subject in all its aspects—historical, geographical, and commercial. [A. G. L. R.]

Wells. See WATER, UNDERGROUND.

Welsh Black Cattle.—In Wales we might expect to find, as Youatt remarks, 'decided specimens of the native productions of our island.' It is difficult to determine the exact relationship between modern Welsh Black Cattle and the ancient British ox, whose remains have been discovered in many parts of these islands, although several attempts have been made in that direction. It is probable that several modern breeds are more or less directly descended from this animal, amongst them being the Welsh, which, owing to the circumstances of the case, may possibly claim a more direct descent from this distant ancestor than most of their contemporaries of the same class. It is certain that Welsh Black Cattle represent a very old race, and may to a great extent at least be rightly regarded as specimens of those 'native productions of our island', of which Youatt speaks.

There must have been in mediæval Wales a number of distinct varieties of cattle, of which the black cattle were one, and perhaps the most important. We have numerous references in Welsh mediæval literature to cattle of colours other than black, such as white, red, dun, and brindle. Recent investigations seem to show that the white and red cattle were introduced during Roman and Saxon times respectively, and were not natives of these islands. The black cattle must therefore represent an older breed, presumably, than either of these. In any case there can be little doubt that the black cattle were crossed with both of these breeds, and possibly with others as well, and it is extremely difficult to say to what extent the present character of Welsh Black Cattle is to be attributed to this admixture of blood. Red cattle are frequently found in Wales in districts where modern breeds of red cattle have never been introduced, and are almost certainly reversions to an ancient red variety which found its way westwards at a fairly early period, and was apparently common in Wales in the Middle Ages. Black with white markings, and brindle, are also common colours amongst Welsh cattle, and even white may be seen, though somewhat rarely. In the Lleyn district of Carnarvonshire, mouse-coloured cattle are occasionally seen, and these are probably the remnants of a very old breed altogether distinct from other varieties known in Wales. Belted or 'sheet' cattle, that is, black with a white belt, also occur, especially in Merionethshire, but there are grounds for believing that these are by no means so old a breed as the other varieties referred to.

This variation in colour, quite apart from any other evidence, suggests a multiple origin for modern Welsh cattle. The difference of type amongst those that are entirely black in colour also points in the same direction. But, for all this, there can be no question as to the antiquity of the Welsh black race, which, in spite of the foreign influences under which it was doubtless brought at various times in its history, still retains many of the features that distinguished it in pre-Roman times. It is probable, however, if not certain, that other traits in the breed are due to these very influences, and that more than one race of cattle of non-Welsh origin, but which were common in early Wales, have left their mark upon the modern breed without affecting its colour. It is probable that down to the beginning of the 19th century, Welsh cattle as a class exhibited much the same variation in colour and type as they did in earlier times. Old writers appear to have been struck by this variation more than by almost any other feature in connection with Welsh cattle. 'Every province of the Principality', says Marshall, 'seems to send out a separate breed.' While there can be no question about the mixed character of the Welsh cattle of this period, especially in the border counties, the majority of the cattle in Wales were perhaps always black, and this has for a long time now been the recognized colour of all cattle of the pure Welsh breed.

Up to the beginning of the 19th century Welsh cattle were divided into several distinct breeds, the chief being the Anglesey, the Pembroke, and the Glamorgan. The last named was sometimes regarded as in some ways the most important of the three, but it has now ceased to exist as a distinct breed. Cattle resembling the old Glamorgan breed in colour, viz. black with a white streak along the back, and a considerable amount of white under the body and on the tail, are still very common in certain parts of Wales, but are no longer recognized as Welsh for show purposes. The Anglesey and Pembroke varieties, that is, the two types that were generally described under these names by the older writers, both remain, and constitute between them the breed that is at present known and officially recognized as Welsh Black Cattle.

The districts in which black cattle are now bred are Anglesey, Carnarvonshire, Merionethshire, and parts of Montgomeryshire in North Wales, and Pembrokeshire, and parts of Carmarthenshire and Cardiganshire in South Wales. The black cattle of North Wales are, generally speaking, of the old Anglesey type, and those of South Wales of the Pembroke, often called the Castlemartin, type. The two types are quite distinct, although no doubt closely related, and up to a few years ago were recognized as separate breeds, each having a herd book of its own. The existence thus of two breed societies with an entirely separate organization served perhaps to accentuate the difference between the two types, and certainly prevented anything in the nature of combined action on the part of North and South Wales breeders. In 1904, however, the two societies were amalgamated under the

name of the Welsh Black Cattle Society, and there is now only one herd book. It will probably take many years to obliterate the marks by which the northern and southern types are differentiated, but the Black Cattle Society as now constituted will no doubt accomplish much more in the direction of the improvement of the breed than was possible formerly. The interchange of stock bulls between North and South Wales breeders, and other means already adopted, will ultimately result in a greater uniformity of type as well as in a more general improvement in the breed.

Welsh Black Cattle may be described as a most useful general-purpose breed, combining beef- and milk-producing qualities to an extent that is exceeded by very few British breeds. There are breeds that grow and feed more rapidly than the Welsh; there are breeds that are better known for their milk, but there is none which combines general utility with the hardiness necessary to thrive under very unfavourable conditions to a greater extent than this breed. The South Wales cattle have always been supposed to be the better milkers, and the North Wales cattle the better feeders. The cattle of West Merionethshire and South Carnarvonshire have generally a high reputation for quality, and those of Anglesey for size and weight. The reputation of Welsh cattle as feeders is largely based upon the remarkable results produced by Welsh bullocks when taken to the midland and south-eastern counties of England, where thousands of them are sent every year. There has been a regular trade in cattle between these parts and the Principality for at least two centuries, and there are no signs of Welsh cattle losing their popularity for the purpose for which they are specially sought. The Welsh cattle that find their way into the English grazing districts are as a class known as 'Runts', a name which at once suggests the character in which they were regarded in the early days of the trade. The particular merit of Welsh 'Runts' is that owing to their hardiness they do very well when wintered out, and when they are put on the rich pastures of the Midlands in the summer they feed rapidly and attain very great weights. For this purpose they are excellent, requiring very little attention, and giving larger returns than any other class of cattle.

As a breed Welsh cattle are somewhat slow in arriving at maturity, and the bullocks do not produce the best results as feeders until they are three years old. They kill well, yielding a higher percentage of carcass than their appearance would seem to indicate, and the beef is in every way of first-rate quality and highly appreciated in the London market, where it is regarded as at least equal to prime Scotch. At the fat-stock show of the Smithfield Club, Welsh cattle generally stand high in the open carcass competition, and have for several years in succession even been placed first against all-comers. The beef yielded by a well-fed, mature, Welsh bullock is remarkable for a high proportion of lean meat and freedom from superfluous fat. Mature cattle of the ordinary description weigh from 160 to 200 lb. per quarter. Those kept somewhat longer than usual and fed for show will weigh up to 250 lb. per quarter and more.

Welsh cows are good milkers, and the milk is generally of good quality. With careful selection they could no doubt be greatly improved in this as in other respects. They are, as it is, looked upon with great favour by many dairymen, for they will thrive on very poor fare, and are generally easy to keep. It is remarkable the amount of milk a herd of Welsh cows on an ordinary hill farm will give, with practically no artificial food or turnips all through the winter.

Until comparatively recently little had been done, except by a few individual breeders, to improve the Welsh breed on systematic lines. In districts where the farms are mostly small, with only a few cows kept in each, and but one bull to serve a large area, it is impossible to effect much improvement except by combined action. Moreover, Welsh cattle as they are have a definite position of their own in the store cattle trade, which they could not hold if they entered into competition with other breeds in which rapid growth and early feeding qualities have been developed, at the expense to a great extent of hardiness and activity. In view of the conditions prevailing in many parts of Wales, and the system generally practised of providing for the store-cattle trade, the late maturity of the Welsh Black breed is not such a serious drawback. That they are capable of much development in this respect, however, is evident from what may be seen in some of the best-managed herds in the country. Much could be done to develop Welsh cattle as a milking breed, and a great deal remains to be done in the direction of uniformity and symmetry of form. Many of them, while they have plenty of size, are badly shaped, with high rumps, and light hind quarters. They are also often somewhat thin on the ribs, and thick-skinned. These are the most obvious defects of the breed. Show specimens are often remarkably fine animals, the females especially being frequently very symmetrical and even-fleshed, whilst retaining the essential features of the breed. The South Wales cattle are often longer in the body than the North Wales type, which are thicker and more symmetrical. They often also have strong curly hair, which in the North Wales type is soft and long. They both have long horns, which are wider and less graceful generally in the southern than in the northern type.

The Welsh Black Cattle Society has done much of recent years to bring the breed into prominence, and to encourage more systematic methods of breeding. Its efforts are bearing fruit at least in the show yard, and their effect will doubtless be felt in other circles as time goes on. The breed owes as much, however, to individual breeders as to the Society. The secretaries of the Society and editors of the Herd Book are Messrs James Thomas and Son, Haverfordwest.

It is not improbable that considerable export trade in Welsh Black Cattle may be developed in the future. They are already highly appreciated in parts of America, and they have been

tried with success in South Africa, where their hardiness of constitution has enabled them to thrive under conditions which had proved entirely unfavourable to other breeds. While they are perhaps not suitable in places where, for various reasons, rapid development is looked for, where soil and climate are such as to make this rapid development difficult to attain, and where hardiness of constitution, together with a capacity for thriving on the scantiest fare, are essential, Welsh Black Cattle deserve a trial, and there is hardly a breed that can, for such a purpose, be recommended with greater confidence [C B J]

Welsh Cobs and Ponies.—Origin and Early History.—The earliest reference to the horses indigenous to the Principality of Wales occurs in Leges Wallicæ, compiled by Howel the Good, King of Wales in the 10th century. Here three distinct types are mentioned (*a*) the *palfrey*, the riding animal that ambled easily; (*b*) the *roway*, *runcy*, or *sumpter*, or the pack horse; (*c*) the *Equus operarius*, the light, able-bodied carting horse that drew the 'kerr' or 'gambo'. This was a little cart on runners which was used to convey the scanty harvest from the hill slopes, or trouse and faggots along steeps where it would have been impossible for a wheeled cart to venture. Probably the light, able-bodied 'carter', the *Equus operarius*, mated from time to time with the better bred riding palfrey, played a great part in stamping the type of pony now familiar as the Welsh cob.

In the Leges Wallicæ there is scant reference to the smaller ponies of the hills. It would seem that even in these early times there existed a strong prejudice against them — a prejudice which in Tudor times culminated in the enactment of the Penal Laws. But in spite of this, these hardy hill ponies continued to flourish in their mountain fastnesses.

Modern Welsh Ponies.—Like other trotting ponies, the Welsh cob is a composite breed. His precise origin and evolution is a matter of conjecture, for no written records of his descent have been kept. Consequently we have no definite information as to the systems adopted by his early breeders, or the aims which they had in view in grading up the cob. It is supposed by some that the Welsh cob was primarily derived from the light 'carter' and the pony of the mountain aforementioned. Since the establishment of the Stud Book in the early part of Queen Victoria's reign, however, an accurate and authentic record of the Welsh cob has been kept. Details will be found in volumes II and III of the Stud Book. It would seem that, early in the Victorian era, there was an infusion of thoroughbred blood. In the early 'forties a renowned Arab sire imported by Mr Crawshay of Cyfarthfa left its stamp on the breed. So it was with the Welsh cob of these early Victorian days, and the stock of a certain old epoch-making sire at that time was responsible for a large and widespread progeny that perambulated Wales, and rejoiced in such various but well-known names to the Welsh cob lover and breeder as the Welsh Flyers, Cardigan and other Comets, Eiddwen Trotting and Briton Flyers, Expresses, Caradogs, Kings and Welsh Jacks, Beaconsfields, Lions and Dandelions. All these were inbred to Mr. Richard Evans's Old Trotting Comet, who was foaled about 1840. This is the breed that has become so noted and celebrated for its pace, courage, and staying powers, and responsible for the good name that the Welsh cob has universally obtained.

From the question of cobs we must turn to the subject of the smaller ponies who frequent the hills, commons, and moorlands of Wales. A certain divergence of shape in these animals has been the subject of comment and discussion. Our Stud Book slightly differentiates two types, as will be seen in the subjoined description of their essential characteristics, as for instance between the pony with finer quarters and the pony with cob character. The cobbier-looking pony is probably the result of some small cob sire being mated with the Hill pony of the district. Many of these showy, trotting, sturdy little animals, perhaps more adapted to the shafts than the saddle, are often seen in our show rings. To instance names of well-known breeders of studs built upon these lines we may mention Mr Marshall Dugdale's, Llwyn, Montgomeryshire; Mr. Miller, Forest Lodge, Brecon, Mr Jones, Dinarth, Colwyn Bay, Mr. R. Greaves, Wern, Portmadoc; Mr T B. Lavis, &c. All these have been possessors of prizewinning conspicuous small ponies who trace back a very near origin on the sire side to a 14-hand-and-over cob parentage.

The other pony we have described as of another type and Arab-descended is principally represented at the present day in Wales by the sons and descendants of a pony called Dyoll Starlight, belonging to Mr Meuric Lloyd. This pony is one of the animals that makes history and becomes in after-days known as an epoch-making sire. Mr Evan Jones's Greylight, the well-known Champion winner of many years at the Royal, Islington, Olympia, and elsewhere, is his most illustrious son. Sir Walter Gilbey's Shooting Star and Mr H D Greene's Ballistite and King Cole are other well-known winners, and sons of this famous little animal.

Points and Characteristics.—The points and characteristics of the Welsh Mountain and Moorland Pony for the guidance of judges and breeders were drawn up and revised, 1908, by Mr John Hill, Marsh Brook House, Church Stretton, Mr H. Meuric Lloyd, Delfryn, Llanwrda, South Wales, and Mr. C. Coltman Rogers, Stanage Park, Radnorshire. Subjoined we give them textually.

Section A, Part I.—The Mountain Pony is considered to be the original foundation from which the other ponies and cobs of Wales are descended, so that this section is placed first in order, and a description of the animal given, which is intended to serve as an instruction to judges in making their awards under the various conditions of the classes under which such ponies are shown.

It has been decided at a general meeting of the Society to divide Section A into two parts. Part I will consist of the bloodlike quality ponies, not exceeding 12 hands in height; Part II, be-

sides applying to ponies of this description, shall also include those of a more cobby type, and ranging up to the height of 12 hands 2 in.

The following are the definitions that are drawn up for the instruction of judges in Part I of Section A.—

General Character.—Hardy, spirited, and ponylike.
Colour.—Any colour.
Head.—Small, clean cut, well set on, wide between eyes and tapering to muzzle
Ears -- Well placed, small, and pointed, well up on head, proportionately close, not lop-eared, but small and pointed
Nostrils.- Prominent and open
Throat and Jaws.—Finely cut
Neck —Fairly lengthy and moderately lean, with a stronger crest in case of a stallion.
Shoulders -Long and sloping well back, fine at the points, with a deep girth
Fore Legs Set square and true, not too far back under the body, and not in at the elbows Long strong forearm, well-developed knee, short flat bone below knee, pasterns of proportionate slope and length, feet well shaped and round, hoof dense
Back and Loins.—Muscular, strong, and short-coupled
Hind Quarters — Lengthy and fine Not cobby, ragged, or 'goose-rumped' Tail well set on and carried gaily.
Hocks. —Wide, large, and clean, parallel with the body, and well let down, shank flat and vertical Neither sickle-hocked nor unduly straight Adequately bent, with long heel or calcis bone. Pasterns of proportionate slope and length, feet well shaped and round, hoof dense
Action —Quick, free, and straight from the shoulder; knees and hocks well flexed, with straight and powerful leverage well under the body as to the hocks, but with such bending of the knees and hocks as will not sacrifice pace and power.

Ponies in this section shall not be docked nor hogged. It is further recommended that ponies entered in this section or exhibited in shows governed by these definitions should as far as possible comply with the further conclusions discussed and arrived at by the Welsh Pony and Cob Society at the annual meeting held at Llandrindod Wells, September, 1907, namely 'That all such ponies shall show, or their owners be able to prove, unquestioned descent on one side or the other (and not further back than the grand-sire or grand-dam) from animals that were foaled or have run wild on the mountains or moorlands of Wales or scheduled portions of the border counties, or are descendants of ponies already entered in Section A of the Welsh Stud Book'

Section A, Part II; and Section B.—The description and points as to colour, head, eyes, nostrils, throat and jaws, back and loins, fore legs and hocks, given in Section A, Part I, for the Mountain and Moorland Pony, would seem to be appropriate for a larger pony entered in Part II of Section A and in Section B. Their ears, however, may be proportionately larger Their neck should be fairly lengthy and well defined where it joins the shoulder, giving the pony a good lookout.

These ponies are as a rule stronger built, and have certain traits of the cob character and type, as described under Sections C and D

In neither of these sections, or part of sections, is docking or hogging a disqualification.

Sections C and D.—It is considered that the same points apply to both these sections C and D, as descriptive of the Welsh cob, the only practical difference between those entered in each of these sections of the Stud Book being the height and proportionate strength and power of the larger cob entered in Section D. It was thought advisable to divide them into two sections, so that breeders could be guided in their selection for the breeding of whichever type they wish to make their speciality. It was also considered that Section D would encourage those cobs which are adapted for mounted infantry and other remount work for the army.

Head.—Small and flat, showing pony character, with fine silky hair under the jaws when in the rough.
Neck.— Well defined where it joins the shoulder, giving the cob a good lookout.
Shoulders Well laid, but strong.
Back and Loins.—Back not too long, loins strong and muscular, tail well set on and not 'goose-rumped'.
Second Thigh.- -Well developed, not too long from stifle to hock, or from hock to the ground
Fore Legs —Should stand well outside the body, and be placed well forward; big knees, flat bone, moderately sloping pasterns; feet round, well formed, not 'boxed' or too big When in the rough there should be a moderate quantity of fine silky 'feather' on the back of the legs. Hard wear-and-tear fetlock joints are absolutely essential.
Action — Free, true, and forcible; and they should bend their knees and hocks as much as is compatible with pace and staying powers

METHODS PURSUED IN THE REARING OF STOCK. —The system that has generally prevailed in Wales in pony-breeding is that the sires run wild on the hill with the mares. In some cases this method was attended with bad results in that it led to promiscuous mating, owing to the existence of undesirable sires, and two-year-old colts being permitted to run loose among the mares To remedy this state of things legislation was sought for, and resulted in the obtainment of the Commons Act, 1908, which provided for the elimination of undesirable sires under certain conditions This should and will probably lead to good results and a better class of ponies all round.

In some places pony associations have been formed, good sires bought, and greater attention paid to the breeding of this kind of stock.

The Church Stretton Hill Pony Improvement Society is perhaps the pioneer of this movement, and their efforts to improve their hill stock by selected sires has been attended with excellent results They have an annual 'drive' and 'round up' of their ponies from the hill, and at the same time an annual show, and an annual elimination and selection of sires for the different herds of ponies on their hills.

Some attention in the past day was also given to the improvement of pony breeds in some parts of Wales, and experiments made for this purpose. The thoroughbred Merlin was turned down among ponies by Sir Watkin Williams Wynn of Wynnstay, and did a great deal to improve the breed of ponies of that sort. Others, too, turned out at various times Arabs for a similar purpose —Lord Oxford, Mr. Morgan Williams of St. Donats (to one of whom probably the Arab

appearance of Dyoll Starlight is traceable), and Mr Richard Crawshay, and though these experiments have never seemingly had the effect of increasing the size of the produce, doubtless by slow action it has tended to improve the mountain breed to a great extent. We cannot leave this subject without referring to the fact of an immigration of Hackney sires in the Principality which has been extensively used to cross with the old Welsh breed of cobs. As this is a matter of controversy, we will not allude to it further than to say that with some it is a matter of regret, with others it is looked upon as a desirable proceeding, inasmuch as it is claimed to enhance the money value of the animal. There is no doubt that an animal bred this way presents a more apparent and taking appearance in the show ring against his more homely looking confrères of Welsh origin. Whether the Hackney is in most respects the superior animal of the two is another controverted point of opinion. For wear and tear, stamina and durability, despite his less showy appearance, the advocate of the old Welsh cob claims the superiority.

Distribution of the Breed.—If we were to take one county in Wales that has been renowned more than others, the pre-eminence of the county Cardigan in the matter of its breeds of cobs and ponies must be acknowledged, and that pre-eminence to a great degree it maintains to the present day. The breed of Old Welsh Flyers, Comets, &c., originally came from these regions. They, however, rapidly spread throughout many other counties of Wales, and more especially perhaps the counties of Brecon, Radnor, and Carmarthen. Though the true-bred Welsh cob and the descendants of Old Trotting Comet and Welsh Flyer are less often found than of yore, the diligence of a seeker after one of this lot may sometimes be rewarded by coming across a true-bred specimen of the strain, more especially if he institutes a search through the pages of the Welsh Stud Book, wherein all the best animals of these Welsh breeds are not only entered and their pedigrees practically tabulated, but the whereabouts and address of owner given.

The distribution of the Mountain and Moorland Pony extends nearly over the whole of the hill area and common lands of the Principality. Large tracts of these lands—places situated like Eppynt Forest (Brecon) or Radnor Forest; all these unenclosed lands that lie to the west and south-west of the River Wye as it flows from Rhayader to Hereford—abound in large mobs of these small active-limbed little animals. Perhaps the counties containing the greatest number may be cited as Breconshire, Radnor, Cardigan, Merioneth, Carnarvon, and some parts of Glamorgan, Carmarthen, and Montgomery. We must not omit some of the border counties where England begins and Wales ends, such as the Black Mountains (Herefordshire), the Church Stretton Hills (Shropshire), &c., where the ponies are and may be described as Welsh, or identical and inbred with the Welsh breed.

Stud Book.—The idea of a society was first mooted in the year 1900. A meeting was called together at the Royal Agricultural Show, Cardiff, 1901, under the presidency of Lord Tredegar, and from that moment the project advanced rapidly and was taken up enthusiastically. Another meeting, largely attended, under the presidency of Mr Charles Coltman Rogers, was held at Llandrindod, when rules were drawn up, and in 1902 the first volume of what has turned out to be a successful society was published. A Council of 42 members was selected by vote of the members of the Society in each county. This Council selected Lord Tredegar as President, and Mr Marshall Dugdale, Mr Charles Coltman Rogers, to occupy the positions of Chairman and Vice-Chairman respectively. The objects of the Society were announced as the improvement and encouragement of the breeding of Welsh Mountain ponies, Welsh ponies and cobs. Qualified judges were named and recommended by the Council to exercise their functions at the various shows in the Principality and elsewhere. The following rules now (1910) in vogue explain the regulations which govern the application for ponies to Stud Book:—

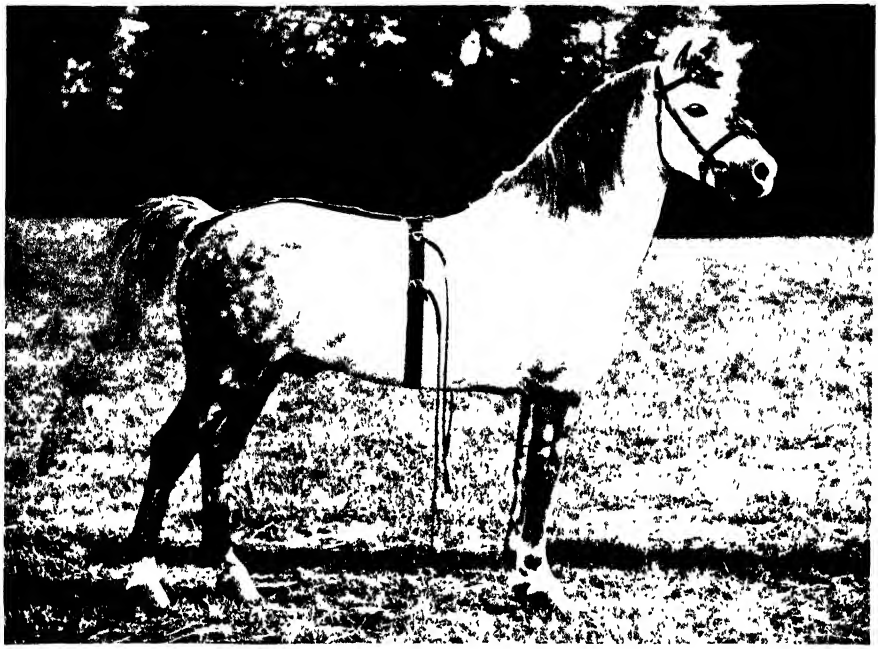
(*a*) *Cobs*.—Ponies and cobs can be fully registered at one year old and upwards, with the following height limits:

	Yearlings	2 Years	3 Years	4 Year	5 Years and upwards
Section A, Part I	11 hands	11 hands 2 in	12 hands	12 hands 1 in	12 hands 2 in
,, Part II	11 hands	11 hands 2 in	12 hands	12 hands 1 in	12 hands 2 in
Section B	12 hands 1 in	12 hands 3 in	13 hands	13 hands 1 in	13 hands 2 in
Section C	13 hands 1 in	13 hands 3 in	14 hands	14 hands 1 in	14 hands 2 in
Sect D.—No height limit					

Ponies entered in Section A, Part I, shall be neither docked nor hogged, and shall show, or their owners prove, unquestioned descent on one side or the other (and not further back than from the grand-sire or grand-dam) from animals that have run wild or were foaled or usually lived on the mountains or moorlands of Wales, or scheduled portions of the border counties, or are descendants of ponies already entered in Section A.

If, at five years old, either a stallion or mare shall exceed the height limit of the section entered in, it shall be transferred to its proper section without any fee. All heights and markings must be registered with entry.

(*b*) The Council shall appoint judges in different districts who shall inspect, and no foundation stallions or mares shall be entered in the Stud Book until a certificate has been signed by an inspection judge; and in the case of a stallion, the certificate must be accompanied by a certificate stating that the stallion is sound, and signed



WELSH PONY STALLION "SHOOTING STAR"
FIRST PRIZE AND SILVER MEDAL, EAST HOW, 1911

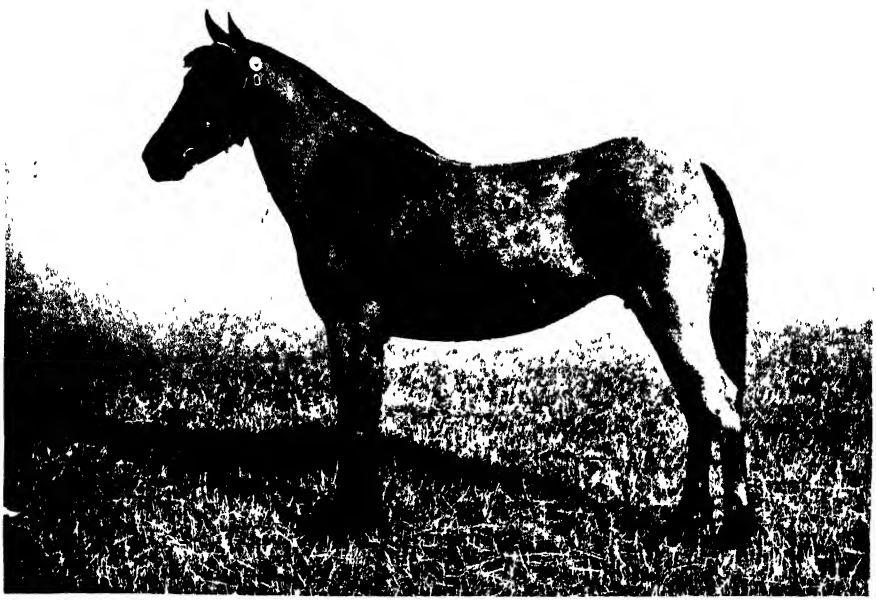


Photo Chris Kerr

WELSH PONY MARE "MOUNTAIN MARVEL"
FIRST AT EAST SHOW, 1910

by a qualified veterinary surgeon. The produce by a registered sire and from a registered dam will be eligible entry.

(*c*) Judges are requested not to grant certificates to any animal they consider to be affected with any hereditary disease. Should the judges have any doubt as to the soundness of the mare, they may call in a veterinary surgeon.

(*d*) All members of the Council are inspection judges, two of whom have power to appoint other judges in the districts when they may be required

Chief Markets, Average Price, etc.—In any attempt to arrive at an estimate of the average price that the Welsh-bred animals—cobs and ponies—realize, it must be borne in mind that there are many causes which might operate that would upset any calculations however well based. There is the price that the breeder obtains, and again the price that the dealer resells at. These are often apt to be considerably at variance. There are other things, too, to be considered. If the breeder gets rid of his stock in lots of three or four, or even larger numbers, he naturally obtains, and expects to obtain, for them, sold in this way, a smaller price than if he sold them singly. What we would like to see is the buyer in closer touch with the breeder. The Welsh Stud Book, purchased from the Secretary of the Society, would give him all information as to the whereabouts and the genealogy of the animal he sought. This is a course that is much more resorted to by buyers, especially from abroad, than it was formerly.

In making, then, an approximate estimate of the price they realize, let it be taken that we refer to the price that the breeder may look to obtain. Besides the ponies that are sold for the pits, there is also a ready sale for the rough little pony of the hills (under 12 hands) for other purposes. At many of the autumn fairs in Mid Wales it is not at all an unusual sight to see droves of little pony suckers being roughly weaned, and parted from their dams for the first time, as they hustle them closely packed into railway trucks.

Such ponies bought in numbers are probably obtained at a cost of £3 or £4 a head. Their destination is often the east of England, where they are sold to farmers, who again, after breaking them, resell them in a few years as riding ponies for children, or for harness work in governess carts.

Such a sight as this is to be seen annually at Newbridge-on-Wye and many other similar market towns in the Principality. Indeed a fair without the presence of some of these animals is quite an exception.

Besides the destination alluded to in the east of England, it is not an uncommon thing to meet droves of Welsh Mountain ponies working their way towards the sea-coast for embarkation to Ireland.

As the pony gets older so naturally does his value increase. A good yearling pony will fetch (especially if registered) from perhaps £7 to £12 variously; at two years old £8 to £12; and at three years old £12 to £15 would be more like the price he would command. Good-looking young mares would fetch the highest price. On several occasions, where a largish number of mares has been bought to send away for breeding purposes to Ireland, the Colonies, or America, the average price has been £10 per annum. But it must be remembered and reckoned that by buying in larger numbers the purchaser will obtain them individually at a lower price than by taking a single animal.

As to the show pony, prizewinning mares, one would probably be nearer the mark if one reckoned their value at from £30 to £60, but of course these are few and far between, and it would not be till after some signal successes that they realized the higher prices of this estimate.

The stallions, winners of the prize ring, would probably not be obtained except at a very high and fancy figure—say £250 or more.

A great many buyers are always on the look-out for a likely yearling of this breed and would probably have to pay some £10 to £50 for a promising youngster, even though his career was unmade.

With ponies, so it is with the cobs when one comes to estimate the price. One may put the ordinary Welsh cob at from £15 to £30 up to three years old, and the probability is that the buyer would obtain for his money a very hardy lasting animal if he came from the old Welsh stock.

Animals crossed with a Hackney perhaps present a more showy appearance, and in consequence might realize a better price, though it is doubtful if they are better workers. An animal, such as Mr Foster's champion, Mid Valley Wonder, bred this way, is estimated by his owner at £1000. On several occasions good show animals, Welsh or Hackney-Welsh, have fetched their hundreds.

Again, Welsh cobs, true-bred Welsh cobs, in the 'eighties bought for prices of £35 or £40, realized in London, when sold at Tattersall's, an average price of £55 or £65, and rumour says gave satisfaction, owing to their hardiness and staying powers, to their purchasers.

In conclusion, we would point out that the Welsh Stud Book, acting on and improving upon the experiences of other such institutions, has set forth in greater detail than any other similar volumes have done, all that can be learnt and known of the previous history and pedigrees of the animals whose names are contained in their registers; and we would further point out, that anyone desirous of supplementing his knowledge of the history of these interesting animals, is able to do so by a perusal of the writings of nearly everyone qualified to write on the subject.

Moreover, should anyone be desirous of purchasing any of these animals, he will find within those volumes not only the pedigrees of the animals he seeks, but the exact localities where they can be found, as also the addresses of the principal breeders. All information, and the purchase of the volumes, can be sought for and obtained from the Secretary of the Society, J. Bache, The Farms, Knighton, Radnorshire.

[C. C. R.]

Welsh Mountain Sheep.—There are in the Principality of Wales several distinct native breeds of sheep differing materially from one another. This accounts perhaps in a great measure for the somewhat vague descriptions given of Welsh sheep by old writers, who seem to have regarded all Welsh sheep as belonging to one breed, which had never been reduced to a fixed and uniform type. There has existed, however, in Wales from time immemorial a distinct race, having certain characteristics of its own, which has played the most important part in the economy of the country for many centuries, and which has a greater claim than any other to be regarded as *par excellence* the Welsh breed. It is now officially described as the Welsh Mountain breed. Hundreds of flocks are maintained on the mountains of Wales, and they constitute the chief wealth of all Welsh hill districts.

Whilst Welsh Mountain sheep are entirely different in appearance from other varieties that are Welsh in origin, such as the Kerry Hill and the Radnor, they are not all of one type. In almost every flock of Welsh Mountain sheep as found on the hills, and in every drove of sheep that one may meet on the road, there will be found two types, differing from each other not so much in size as in face colour, the one having a yellow, or tan, and the other a purely white, face. Ordinary Welsh Mountain sheep are a mixture of these two types, which in all probability represent two ancient races having a somewhat different history. As far as is known, however, both types are equally Welsh in origin. In certain parts of Wales the ordinary hill sheep are still more mixed in character, there being amongst them many speckled, or 'dirty' faces. In the parts of mid-Wales adjoining the Kerry Hill country, these speckled-faced sheep may very possibly be the remnants of the old variety which is now represented by the modern Kerry Hill (Wales) breed, and are therefore not, properly speaking, Welsh Mountain sheep at all. In other parts of Wales, where speckled-faced sheep are found amongst hill flocks, it is known, in many instances at least, that such individuals are the result of crossing with Scotch Blackfaced rams—a cross which has often been tried in Wales, but not as a rule with very great success. The Whitefaced, thick-set sheep sometimes found on some of the better hill pastures in Wales are likewise the result of crossing with Cheviots, to which they often bear an unmistakable resemblance. It should be noted that these cross-bred sheep are only found in certain districts in Wales, and it is a mistake to suppose that crossing has been carried on to any material extent in the country as a whole, or that the original character of the Welsh Mountain breed has been sensibly modified by this means.

The great sheep districts of Wales, where the Welsh Mountain breed is found in its purity, are the uplands of Carnarvonshire, Merionethshire, Montgomeryshire, and Breconshire. In parts of Cardiganshire, Denbighshire, and Glamorganshire, sheep-farming is also carried on to a considerable extent. Perhaps the most important counties in the Principality, as far as Welsh Mountain sheep are concerned, are those of Carnarvon and Merioneth. In all these districts the same type of sheep, as regards breed, is found, but they differ in size and quality according to the character of the pasture and the general nature of the district. The sheep on Plynlimon, the Berwyn range, the Mawddwy and Tal-y-llyn districts of Merionethshire, and the northern part of Carnarvonshire are generally regarded as the best, being bigger and stronger sheep and generally having finer wool. Of the two types, the white- and tan-faced respectively, which are found together in most flocks, preference is given to the latter owing to its greater hardiness, and the white-faced variety will no doubt be largely eliminated in time.

Welsh Mountain sheep as they are found today may be described as a small and an exceptionally hardy breed, mostly with tan faces and legs, a somewhat long, narrow body and rather short, fine wool. They are remarkably active, and it is with the greatest possible difficulty that they are kept within bounds. Well bred and carefully chipped specimens are particularly handsome, and there is hardly a breed that can match them for grace of form. They produce mutton of rare quality and flavour, which is of the highest repute in the London market, and is included in the menu as a special delicacy in hotels and restaurants. Genuine Mountain sheep weigh 7 or 8 lb per quarter, but field fed Welsh wethers will weigh up to 12 lb per quarter and more.

Welsh Mountain sheep are capable of much improvement, as is shown by the success that has attended the efforts of many well-known breeders in the Principality. The 'improved' Welsh is a much larger and heavier sheep than the ordinary mountain type. They are more prolific also, 'twins being rare amongst sheep kept on the mountain', more uniform as regards type, and fatten quicker. Much good in the direction of more careful breeding has followed the establishment of the Welsh Mountain Sheep Flock Book Society. The Society was formed in 1905, and the first volume of the Flock Book was issued in 1906. The secretaries of the Society are Messrs T. and W. Leathes, Ruthin, North Wales. The establishment of the Welsh National Agricultural Society, and the inclusion of separate classes for Welsh Mountain sheep in the schedules of the Royal and other large shows outside Wales, have also done much of recent years to draw attention to the breed and to encourage breeders in the work of improvement. The 'improved' flocks are kept in the lowlands, and are specially suitable for Wales. They retain their mountain hardiness to a very great extent, and combine with it considerable size and excellent quality. In many cases, pure Welsh lambs fatten as quickly and weigh as heavily on the same class of land as the cross-bred lambs that are so popular in the country.

It is the usual practice in Wales to keep the flocks on the mountain from about May Day till November. They are brought down to the lowlands in the winter, except in cases where the hill affords somewhat better pasturage than the ordinary mountain, and it happens to be contiguous to the rest of the farm. Welsh hill

flocks vary in size from 100 to 5000, the actual number of sheep depending upon the amount of mountain land attached to the farm. The unenclosed mountain is generally apportioned between the farms having rights of pasturage upon the land—a remnant doubtless of tribal organization—and the amount of land thus allotted to each holding varies very much. The portion belonging to each farm is known as a 'sheepwalk' or 'liberty'. Most of the larger sheepwalks are unenclosed, and the sheep are kept within theoretical boundaries by constant shepherding. The shepherd has to be as vigilant in preventing the stock from adjoining sheepwalks from trespassing upon his ground, as in preventing his own sheep from straying. Where large flocks are maintained on the mountain it is often found that there is insufficient accommodation for the sheep on the lowland part of the farm, and it is a fairly general practice to send the male lambs away to winter, a certain fixed price per head being paid for their keep from October to April.

Lambing generally begins about the end of March. As a rule there is very little trouble with the ewes at this time except after a very hard or wet winter. Welsh Mountain lambs have a characteristic brown patch in front of the withers at birth—a vestige probably of dark-coloured ancestors—but it disappears entirely as they grow older. It is common also to find a number of black lambs in hill flocks every season.

Welsh Mountain sheep produce wool which, of its class, is of good quality, though somewhat short. The fleece is fairly close, and weighs on the average from 2 to 2½ lb. for ewes and wethers, and 3 to 5 lb. in the case of rams. The 'improved' sheep will yield considerably more than this, rams' fleeces weighing up to 8 lb. Welsh wool varies a good deal in quality according to the character of the sheepwalk and the amount of attention paid to selection. In some cases it contains a large proportion of coarse white hair known as 'kemp'. It is difficult to find mountain wool that is free from this, as even in well-bred sheep one finds a considerable amount of kemp in the wool about the thighs, and, indeed, many hill farmers prefer to have a little of it in the wool, as it is regarded as an indication of hardiness.

The old practice of keeping the wethers until three or four years old has to a great extent been discontinued in many districts, the lambs being either sold off as stores, or fattened, where this is practicable. This change in the system of management has been brought about partly by the fall in the price of wool and partly by the demand for young mutton on the part of the consumer. The practice, however, is by no means general throughout the country, and there is no difficulty in obtaining Welsh wethers for feeding, though they are seldom kept to the same age as formerly. The general custom is to draft the wethers at two or three years old and sell them in the back end of the year to lowland farmers for feeding, at prices varying from 14*s.* to 22*s.* a head according to the season. They are somewhat slow feeders, and, when the price of store sheep is high in the autumn, do not leave much margin for profit. Sometimes, however, they pay very well, and they are always saleable.

The ewes are usually drafted in their fifth year, and many thousands of Welsh Mountain ewes are sold to the lowland districts of Wales and the English counties every autumn for the rearing of fat lambs. No class of draft ewes is more profitable. They may be bought at from 12*s* to 20*s* a head, and being exceedingly hardy, their winter keep amounts to very little. They are good nurses also, and besides rearing excellent lambs, they do well themselves when taken to even moderately good land. The most popular breeds for crossing with Welsh Mountain ewes for this purpose are the Shropshire, Southdown, Wiltshire, Kerry Hill, and latterly, the Ryeland.

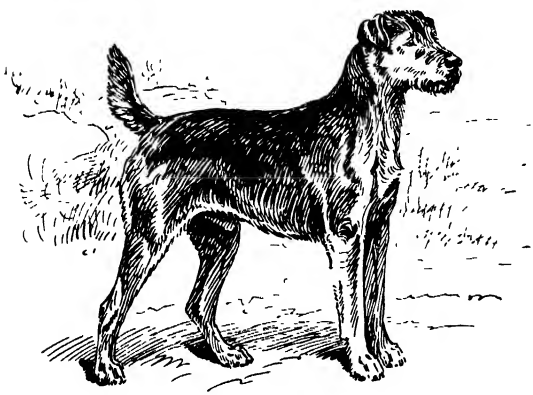
In many parts of Wales, hill flocks might be greatly improved by more systematic selection and the introduction of fresh blood. The improvement of the breed generally being the aim of the Welsh Mountain Sheep Flock Book Society, its efforts on behalf of the 'improved' Welsh breed will ultimately no doubt bear fruit in mountain flocks also, for although the 'improved' sheep would not perhaps retain their size and quality if turned to an ordinary mountain sheepwalk, there can be little doubt that the use of 'improved' rams in hill flocks would result in a marked improvement in many districts. The conditions on the mountains are so rigorous that hill farmers are naturally averse to introducing any element which might by any possible chance impair the hardiness of their sheep. The practice of buying 'improved' rams, however, for service in mountain flocks is extending. But whilst much improvement is desirable in certain directions, Welsh Mountain sheep must always remain a small, hardy, and active breed; and if they are to thrive on the scantiest fare, and prove a source of profit to their owners, having regard to the particular nature of their surroundings, it is essential that they should not lose, by any system of management, those particular characteristics that have hitherto made them so valuable an asset to the farmers of the Principality.

[C. B. J.]

Welsh Pigs have not of recent years improved to anything like the same extent as have the pigs in some other parts of Great Britain. Amongst the causes assigned for this want of attention to animals which play so large a part in Ireland are the want of local shows, the limited consumption of pork, and the absence of bacon factories in which the pigs could be converted into bacon. The Welsh pigs appear to have been utilized for the purpose of the disposal of the inferior produce of the farm, and more particularly of the dairy by-products, which are chiefly available during the summer months. This results in the major portion of the pigs being ready for the fat-stock markets in the months of August and September, when very considerable numbers of them are sent into England and thus tend to reduce the scarcity of fat pigs, which is frequently observable in the midland and southern portions of England during the latter portion of the summer months. The Welsh pigs are mainly white in colour, some-

what long in the snout and legs, coarse in bone and hair, light in ham and carcass, and give one the impression rather of ability to continue to consume a large quantity of food for a long period without becoming overladen with fat, than to produce pork of high value at little expense whilst they are comparatively young The sows are prolific and good milkers, and the youngsters are hardy, and when they are weaned they *pen up well*, as the dealers term it, or, in other words, they give the impression of greater weight and size than they actually possess when in the pens at market or when hawked about in the dealers' carts for sale The length of leg and general coarseness of body greatly assist in the deception. Of recent years some Large White boars have been introduced These have improved the quality of the hair, skin, and bone, but greater benefit appears to have been derived from the introduction of Middle White boars, particularly in the quality of the flesh, the compactness of frame, and the early maturing properties. [S. S.]

Welsh Terrier.—The Welsh Terrier, like the Irish, was practically unknown until within



Welsh Terrier

recent years, but of late has high merits as a vermin dog and attractive appearance have united to gain him many friends. In coat and build he somewhat resembles the Irish Terrier, but he is lower on the leg and rather more cloddy throughout His skull is flat and somewhat wider than that of the Fox Terrier, his muzzle of fair length and powerful, eyes small and dark hazel in colour, ears small but rather thick, and carried close to the head with the points forward. Body short, well ribbed up, shoulders sloping, and fore legs straight and fairly heavy in bone. The coat must be hard and wiry, and the colour black and tan, or black, grizzle, and tan, the dark markings being on the ears, head, body, and tail. Average weight about 20 lb. As observed above, the Welsh Terrier is a first-rate vermin dog either on land or in water, and being of a bright, intelligent disposition he forms a most excellent companion to residents in the country. Hence his rapidly increasing popularity is easily accounted for. [V. S.]

Wensleydale Cheese.—This blue-veined variety of cheese has its origin in the Wensleydale district of Yorkshire, which extends from Northallerton to Hawes junction. It is in Wensleydale and the neighbouring dales where the largest quantities of this cheese are still produced. The milk is particularly suited for the type of cheese, as it is produced from sweet pastures on limestone formation.

When well made and ripened, Wensleydale cheese is no doubt one of the finest cheeses, but it is undoubtedly one of the most difficult of all to produce of uniform prime quality, and may be said to resemble Stilton cheese in this respect. There are two varieties of Wensleydale cheese made, the Stilton-shaped and the flat. The Stilton-shaped Wensleydale cheese may be called the summer cheese, whilst the flat cheese is the kind chiefly made throughout the winter though in many dairies flats are made throughout the year. The typical Stilton shaped Wensleydale cheese measures 7 in. in diameter by 10 in. high, and weighs when ripened about 15 lb. The flats are made in shapes of various sizes, but the commonest weighs about 14 lb., and measures 9½ in. in diameter by 5 in. deep, buyers generally calculate that eight of these cheeses will weigh 1 cwt The flat cheese do not as a rule, and are not expected to, develop blue mould inside in a similar manner to the Stilton shapes Flats made in winter practically never go blue, and are what are known locally as 'hay' cheese, or cheese made from milk produced by cows on winter keep Recently several factories have started the manufacture of Wensleydale cheese, the flats being the common type made

Process of Manufacture

There are various systems of making Wensleydale cheese, but the chief one adopted in the Wensleydale district is the following The night's milk is strained into the tub or vat, and in hot weather is cooled to about 65° or 70° F The next morning the cream which has risen is skimmed off, and the fresh warm morning's milk is added to the vat. The cream is heated to a temperature of about 90° F., and poured into the mixed milk now in the vat, and the temperature of the whole is regulated to the degree of heat at which it is desired to add the rennet. Generally speaking, the rennet is added at a temperature of 80° F, but it varies between 80° and 86° according to the time of the year. When the weather is cooler and the milk is richer, the temperature is higher than the usual 80°. Rennet extract is generally employed, though some makers still use home-made rennet The quantity of commercial extract usually employed is 1 dr. to every 4 or 5 gal. of milk. The rennet is first mixed with a little cold water, and then stirred into the milk for about five minutes, after which the surface is kept agitated for a few minutes longer

to prevent the cream from rising. Coagulation takes about 1¼ hour. When the curd is sufficiently firm, it is cut either with ordinary knives or with the more recently introduced American curd knives, to reduce it to cubes of about ¾ in. in size. With the American knives the vertical knife is used the first, the curd allowed to rest for a few minutes, and then the horizontal knife is employed. The curd is again allowed to remain for a few minutes, and is then stirred by hand for about five to ten minutes. Any curd adhering to the sides and bottom of the tub is loosened, and the curd is thereafter allowed to pitch or settle at the bottom of the vat, where it is left undisturbed for about twenty minutes, until such a time as sufficient acid has developed in the whey to indicate that it is time to remove the curd to the cooler. The whey is then drawn off, and the curd piled at one end of the vat, and allowed to remain for ten minutes covered over with a cloth. It is subsequently cut in large 6-in. squares and removed on to the wooden racks in the cooler, the racks being covered with cloths. Here it is covered up and allowed to remain for twenty minutes, and the process of opening out, cutting, and turning being repeated every twenty minutes until sufficient acid has developed in the curd to necessitate it being broken up and salted. The grinding or breaking up of the curd may be done either by hand or by means of a curd mill, but in any case the consistency of the curd should be such that it can easily be done with the fingers, for although not so soft as the Stilton curd when vatted, it is sufficiently soft to be broken with the fingers. When reduced to pieces about the size of filbert nuts, the salt should be mixed in. It is advisable to weigh the curd and add salt at the rate of 1 oz. to every 4 lb. of curd during the summer and autumn, or 1 oz. to every 3 lb. of curd in spring and winter. Many makers prefer to pickle their cheeses rather than add salt to the curd, and this is done by immersing the cheese in a strong solution of salt water, made by boiling the water and dissolving sufficient salt in it to give it a density enough to float an egg. The cheeses, after being pressed, are soaked in this pickle or brine for two or three days. The curd is now moulded, and for this purpose the moulds are first lined with a coarse-textured or straining cloth, the curd being lightly filled into the cloths and the follower put on top, but no pressure added. In the course of a few hours, or before leaving for the night, the cheese should be taken out of the mould and turned, either using a fresh cloth or putting it back into the same one. Next morning the cheese is taken out, turned, and put back in the mould in a thin muslin cloth. It is then put to press, and just a small amount of pressure added, equal say to about 1 cwt., which in the course of two or three hours is raised to 3 cwt. The pressure remains on for about eight to ten hours altogether, varying with the nature of the curd. In some cases more pressure is required, in others less, but the object is always to produce a cheese that is fairly firm and yet has sufficient air left in it to enable blue mould to develop throughout. The flat cheeses may always be pressed more than the Stilton-shaped ones. After removing the cheese from the press, a brown linen bandage is sewn carefully on to it, and the cheese is then removed to the drying room, where it remains for about seven to ten days until the coat is properly formed. It is then moved to the ripening room or cellar, where the atmosphere is moist, and where, if turned daily, it should become blue moulded in the course of about four to six months' time.

Very few makers work systematically in producing the cheese, but great difficulty would be obviated if the acidimeter were used and all operations conducted on acidity determinations. The following acidities represent good practice —

Mixed milk ready for renneting, ·18 to ·2 per cent acid, calculated as lactic acid
Acidity when curd is cut, ·16 per cent
Acid at time whey is drawn off, ·18 per cent.
Acid in whey from curd when ready for salting, 35 to 45 per cent.
Acid in whey escaping from cheese when put to press, 1 to 1·2 per cent

[C. W. W-T.]

Wensleydale Sheep.—This noted breed of sheep, for the development of which there are two distinct associations and flock books, may be said to be native to the beautiful Wensleydale district of Yorkshire, where it is chiefly bred. It finds a home in most of the Yorkshire Dales, such as Wharfedale, Nidderdale, Swaledale, and also in the Skipton in Craven district. It is supposed to have been descended from the old Teeswater breed of Yorkshire known as the 'mugs', which formed at one time the chief stock of the plain of York and of Cleveland. The Teeswater sheep were improved by crossing with Leicester rams, and by carefully selecting the best ewes and the best ram progeny, a fairly uniform type of sheep was evolved some forty or fifty years ago. The improved breed was somewhat clumsy in appearance, but yielded a heavier and more compact carcass, produced more lean and finer-flavoured mutton, and was of earlier maturity, whilst the staple of the fleeces became finer and closer than either of the breeds from which it was originally derived. Because of their being extensively bred in Wensleydale and district, the name 'Wensleydale' was given to the sheep to distinguish them in the show yard when the Yorkshire Agricultural Society commenced to give prizes for them. As already mentioned, there are two associations for the maintenance and improvement of Wensleydale sheep, each association issuing a separate flock book. There is the Incorporated Wensleydale Blue-faced Sheep-breeders' Association and Flock Book Society, formerly known as the Pure Select Wensleydale Sheep-breeders' Association and Flock Book Society, the hon. secretary of which is Mr J. A. Willis, Carperby S.O.; whilst the other is that of the Wensleydale Long-wool Sheep-breeders' Association and Flock Book Society, the hon. secretary being Mr. R. B. Hodgson, Spennithorne, Leyburn. Both these gentlemen are breeders of Wensleydale sheep and take a deep interest in the development of the breed. These two societies were founded in the year 1890. To the outsider the necessity for two separate

flock books for this breed is not very apparent, but so far as can be ascertained the differences of opinion between the members of the two societies are so pronounced as to make an amalgamation of the two breeds at present impossible. The admission of animals to the Flock Book of the Wensleydale Blue-faced Sheep is doubtless somewhat more stringent from a flock-book point of view than in the case of the Wensleydale Long-wool Sheep.

The following are the characteristic points given in the Flock Book of the Wensleydale Blue-faced Sheep —

	Points
Wool bright and lustrous; flat staple of medium breadth and good length; each staple curled or pirled out to the end. Wool of equal staple all over the back and sides from shoulder to breech The whole fleece free and open, and free from mistiness on the back. When the sheep is turned, the belly, and particularly the scrotum, should be well covered with wool and free from hair	20
Head broad at the muzzle, especially in rams; back of head flat and wide between ears. The face, seen in profile, should show good depth of jaw. Ears of good size, neatly set on and well carried. Head and ears of a deep-blue tinge, which often extends to the rest of the body. Entire absence of hair about the forehead, back of head, and ears Tuft of wool on forehead Back of head, especially round the ear roots, covered with fine wool Free from *coarse* hair on the rest of the face Eyes bright and full	20
Neck of good length and strong, rising gracefully from the shoulders, and carrying the head a good height	10
Shoulders and Crops.—Shoulders well laid back into the crops, which should be wide and full	10
Chest coming well down and forward between the fore legs, and wide on the floor of the chest and hockster	10
Back, Loins, Sides, and Quarters —Ribs well sprung, deep, and great length of side Loins broad and well covered with firm flesh along the back Hind quarters long, square, and nicely packed Tail broad	20
Thighs, Legs, and Feet —Thighs well down to the hock, large and broad behind Twist full. Legs with plenty of bone, but free from coarse hair, straight set on at each corner and well apart Hind legs with a nice covering of fine wool from hock to hoof Feet moderately large and well formed	10
Total	100

The points given by the Wensleydale Long-wool Sheep-breeders' Association to be used for judging Wensleydale rams are as follows.—

	Points.
Head —Face dark Ears dark and well set on. Head broad and flat between ears. Muzzle strong in rams. A tuft of wool on forehead. Eyes bright and full Head gaily carried	15
Neck moderate length, strong, and well set on to the shoulders	10
Shoulder broad and oblique	5
Chest deep and wide	10
Wool bright lustre, curled all over body, all alike in staple	20
Back and Loins.—Ribs well sprung and deep. Loins broad and covered with meat. Tail broad. Flank full	25
Legs and feet straight, and a little fine wool below the hock Fore legs well set apart. Hind legs well filled with mutton	15
Total	100

It will be seen by the contrast of the two societies' points that there is a considerable agreement of ideas From an outsider's standpoint, the Long-wool would appear generally to have a lighter-coloured face and more hair on it than the Blue-faced sheep.

The Wensleydale sheep may be said to be used chiefly for crossing with other breeds, and for this purpose it is in demand over the north of England and in the south of Scotland Of recent years a considerable number of sheep have been exported. The chief cross is the Wensleydale ram with Black-faced Mountain ewes. The dark-coloured face in the Wensleydale sheep is much sought after on account of the fact that a ram of this type gives rise to dark-faced lambs (a point much valued by butchers). In the east of Yorkshire and Lincolnshire, where a large number of these crosses are fattened, they are called 'Mashams'. When these half-bred ewes are crossed with the Wensleydale ram a 'twice cross' is produced, and this is the most popular sheep in the Dale districts. The great advantage of this cross is that it produces a very fine quality of lean mutton, much superior to and containing less fat than the Leicester-Wensleydale cross. As a breed Wensleydales are not kept for fattening They are very prolific -a characteristic probably inherited from their ancestors, the Teeswater sheep— and on an average will produce about two lambs apiece. In a flock of thirty ewes, nine or ten triplets is not uncommon, and four lambs per ewe is by no means a rare occurrence One of the great merits of the Wensleydale sheep for crossing is that it is very hardy and withstands the winter well, though it is not usually put upon the hill pastures for rearing, but kept in the homelands

Some of the chief breeders whose sheep belong to the Blue faced Flock Book Society are as follows Lord Henry Bentinck, Underley Hall, Kirby Lonsdale, Wm. Rhodes, Lundholme, Westhouse, Kirby Lonsdale, Wm Dinsdale, Lower Bolton, Redmire, J H. Close, Carperby S O , the executors of the late Thos Willis, Carperby Amongst those whose sheep are entered in the Long-wool Sheep Flock Book may be mentioned W. Foster, Thoresby, Carperby; J. Hargrave, Wath, Melmerby, R B. Hodgson, Spennithorne, Leyburn, E. Horseman, Richmond, Yorks; Metcalfe Spensley, Redmire

The half-bred or first-cross hogg will, if well wintered, grow a staple of wool 15 in. long and clip a fleece of 10 to 12 lb by the end of May, which is about the usual time for clipping in the Dale districts Washing takes place about the middle of May, or two weeks prior to the clipping, though it is not now a regular practice to wash the sheep before clipping. Such a hogg will weigh from 15 to 17 lb. per quarter, and provide exceptionally fine-quality lean tender mutton—possibly as good as can be obtained. A twice-cross shearling will yield about 12 to 14 lb. of wool, and will weigh when fat 22 to 25 lb. per quarter The pure Wensleydale sheep, when carefully fed and tended, grows to great size and substance in a comparatively short time. Lambs six months old can be fed up to a live weight of some 13 st., and shearlings to 24 st.,

the latter often clipping 15 to 16 lb. of wool; whilst a two-shear ram will attain a live weight of about 32 st. The staple is of medium breadth, long, of a bright lustre and particularly silky, usually curled, and covers nearly the whole surface of the body, including the forehead, eyes, ears, &c. Hairy wool is considered objectionable.

A large number of ram lambs are purchased for service in the autumn, and in order to bring them forward the ewes are usually hand-fed throughout the summer, being given a little cake, split peas, crushed oats, &c. The lambs themselves are hand-fed, and put on the aftermath as soon as it is available. Winter feeding on hay and turnips is usual, whilst from the beginning of the new year, bran and oats, or some such addition of concentrated food, is given until lambing time, which usually occurs at the end of March or the beginning of April.

The most important sale is that held at Hellfield in October, but those who require lambs for taking to the south require to buy privately. The sales generally occur too late for buyers to purchase rams for stud purposes the same season, since breeding takes place earlier in the south than in the Wensleydale district. Sales and markets are held at York, Northallerton, Hellfield, Leyburn, Kettlewell, Middlemoor, and Kirby Stephen (Westmorland).

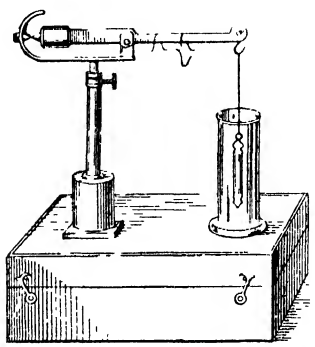
The average prices for shearling rams range from £6 to £10, ram lambs, £5 to £7, shearling ewes, £3, ewe lambs, £2.

Shearling rams of special merit fetch from £12 to £35, and ram lambs £10 to £30. £25 is not an uncommon price paid by breeders for sheep of extra good quality. [C. W. W.]

West Highland Cattle. See Highland Cattle.

Weston, Sir Richard, flourished in the reign of James I, and was the English ambassador at the Court of the King of Bohemia. In the agricultural world he is chiefly noted for his treatise on the Agriculture of Flanders, a work which attracted widespread attention and had a powerful effect on the practice of agriculture in Britain. Another work, entitled Brief Discoveries of the Ways and Means for Manuring and Improving Land, is also worthy of mention. [R. H. L.]

Westphal Balance, an instrument used for determining the specific gravity of milk, which is based upon the familiar principle of the steelyard. Although less convenient than the lactometer, it is more accurate. Briefly, it consists of a balanced beam, the longer side of which is notched into ten divisions and carries a plummet suspended from a hook at the end. Along with the instrument is provided a glass cylinder and a set of four riders corresponding respectively to the first, second, third, and fourth decimal places of the sp. gr. number to be determined. To take the sp. gr. of a milk, the sample is well mixed, filled into the cylinder, and the plummet completely immersed therein. The largest rider is placed on the end hook, and the other riders then adjusted on suitable notches until the pointer indicates equilibrium. The sp. gr. is then read off by counting one for the rider on the hook, the second decimal place for the notch upon which the second rider is placed, the third decimal place for the notch carrying the third rider, and the fourth decimal figure for the notch of the smallest rider. Thus if the second rider is on the third notch, the sp. gr. is 1·03, if in addition the third rider is on the first notch, the sp. gr. is 1·031; and if, further, the smallest rider is on the eighth notch, the sp. gr. is 1·0318. Unless the milk happens to be already at 60° F., the temperature must be taken and correction to



Westphal Balance.

60° F. made from tables, so as to render all sp. gr. determinations comparable with one another. [H. H. G.]

Wet Grains. See Brewers' Grains.

Wheat is one of the most important of all plants cultivated by man, and among cereal grains used for the manufacture of bread it occupies the first place. Where improvements in the social and economic conditions of civilized races are taking place, bread made from the flour of wheat is increasingly used, and the area devoted to the growth of the crop is extending annually.

Its cultivation was begun in prehistoric times and was well advanced among the ancient Egyptians and other early races.

The ear of wheat consists of a central notched rachis or axis on the opposite sides of which are arranged two rows of spikelets, those of one side alternating in position with those on the other. Each spikelet has a thin central axis bearing from two to five flowers, each enclosed by a pair of scaly leaves or glumes ('chaff'). The upper flowers are often abortive, producing no ripe grain. The lowest or empty glumes of the spikelets are oval and boat-shaped, with a short blunt terminal awn. The flowering glumes are similar in shape, and may terminate in long conspicuous awns or 'beards' or may be 'beardless', *i.e.* without awns or with short ones only.

The grains or fruits of the plant are free from the enclosing glumes, and may be white, yellow, red or reddish-brown in colour. The endosperm or floury part of the grain is sometimes very white and opaque, appearing like chalk when cut across. Grains with such 'starchy' contents are usually soft, and are termed 'weak' by the miller, they generally yield flour which makes a somewhat small loaf of dense texture when the dough is

prepared with yeast and baked in the ordinary way

The endosperm of other varieties of wheat is frequently hard and translucent, resembling horn or flint when cut across. Samples with grains of this character are termed 'strong' wheats by millers, and the flour from them yields loaves which are comparatively large and spongy in texture. See art. Flour.

Many hundreds of varieties of wheat are cultivated in different parts of the world, but the wild ancestors from which they must have originated in the dim ages of the past are not known with certainty. It is not even clear whether the various forms which we now know have all arisen from one or from two or more species.

For present purposes we may divide cultivated wheats into two groups.

A Spelt wheats, the ears of which are brittle, breaking transversely at the notches of the rachis into short lengths, each piece of which carries an attached spikelet. The grains of these wheats are firmly enclosed between the glumes and do not thrash out.

B Wheats whose ears have tough axes, which remain unbroken after thrashing. In these the grains are so loosely held by the chaff that they become free when the ears are thrashed.

A The spelt wheats are probably the most ancient forms, and less differentiated from their wild prototypes than those with tough ear axes.

The following belong to this group.

1 One-grained Spelt or Small Spelt (*T. Triticum monococcum*, L.).—This wheat is generally considered a distinct species, and so closely resembles *Triticum aegilopoides*, Bal., a wild species of grass which is found in the Balkan peninsula and Western Asia, that it has doubtless originated from the latter.

Small spelt has a thin, wiry stem about 18 in. to 2 ft. high, with pale grass-green leaves. The ears are flat, 1 to 2 in. long, very brittle, and the spikelets usually contain only one grain each. The flowering glumes have five awns, and the grain is flinty, like a small rice grain in shape, laterally compressed. It is a hardy kind, but rarely grown except in the mountainous districts of Central Europe.

2. *Triticum dicoccum*, Schr., known as Emmer in Germany and Amidonnier in France, is a primitive type with bearded ears and spikelets, usually containing two ripe grains. The spikelets are arranged very closely together on the brittle rachis.

The grain has a soft white starchy endosperm. Emmer is a wheat which is grown as a spring-sown crop in parts of Germany, Austria, and other southern European countries. It is of little agricultural importance.

A wild species (*Triticum dicoccoides*) recently discovered in Syria and Palestine appears to be the plant from which Emmer has probably been derived.

3. Common Spelt (*Triticum Spelta*, L.) has long narrow ears, the spikelets of which are arranged on the rachis at comparatively wide intervals. A number of varieties are known, some bearded others beardless, with glumes of white, red, or blackish tint. The grain is opaque and the flour very white; the latter mixed with rye flour makes excellent bread.

Spelt wheat is an old kind known to the Greeks and Romans, and still cultivated in small quantities in many parts of Spain, Italy, Switzerland, Germany, and south of France. Stapf has recently suggested that it has been derived from *Triticum* (*Aegilops*) *cylindricum*, a wild grass common around the northern shores of the Black Sea.

B Belonging to the wheats with tough ear-axes and loose grains, the following may be recognized.

(1) Macaroni, Hard or Flint wheat (*Triticum durum*, Desf.).
(2) Polish wheat (*T. Polonicum*, L.).
(3) Rivet or Cone wheat (*T. turgidum*, L.).
(4) Dwarf wheat (*T. compactum*, Host).
(5) Common Bread wheat (*T. vulgare*, Vill.).

1 Macaroni or Hard Wheat (*T. durum*) possesses ears the flowering glumes of which bear long stiff awns. The glumes are sharply keeled down the middle from end to end and may be white, red, or black. The grains are long, narrow, and pointed somewhat at both ends, usually, though not always, they have flinty, translucent endosperm. The straw is tall and stiff, with solid pith like a rush, or only slightly hollowed. Macaroni wheats are grown extensively in southern Europe and North Africa, the seed being sown in spring. On account of the hardness of the grain they are difficult to grind. From the flour, macaroni, vermicelli, and other similar glutinous products are prepared. Recently, new improvements in milling have made it possible to utilize these wheats in the manufacture of flour for bread-making.

T. durum appears to be related to Emmer in some of its characters, and may possibly have had the same ancestry as the latter kind of wheat.

2 Polish Wheat (*T. Polonicum*) is a striking form with tall straw and long, loosely constructed bearded ears. The spikelets have three or four flowers, two of which ripen grain usually. The empty glumes are very long—over an inch sometimes—and the flowering glumes have awns. The grains are long and flinty, in shape like those of *T. durum*, and the whole plant is covered with a glaucous bloom.

The name Polish was given to the plant by Morison about 1680, apparently under some misapprehension of its origin, as it does not grow in Poland. It requires a warm climate for satisfactory development, and is cultivated chiefly in Spain and Italy.

Although it is usually considered a distinct species, the writer is of opinion that it is a monstrous form or sport from one of the macaroni wheats.

3. Rivet or Cone Wheats (*T. turgidum*) have tall, almost solid straw, with characteristic square ears, and long rough awns which in some varieties drop off when the grain is ripe. The glumes are keeled and generally covered with soft velvety hairs, though some forms have smooth chaff. The glumes may be white, red, bluish or blackish in colour. The grains are short and rounded, blunt at one end, and the endosperm is usually starchy and opaque. The flour is generally

'weak', but certain varieties grown on some soils yield a 'strong' flour, the latter forms approximate in many of their morphological characters to *T. durum*.

Rivet wheats are grown largely in Germany, France, and Italy, and to some extent in the southern parts of England They have a long growing period, ripen late, and give large yields of grain. In cool temperate regions they should be sown in the warmer districts, where they give the best results on stiff, loamy soils.

A sport of this type of wheat with branched ears is sometimes known as Miracle, Mummy, Egyptian, or Wonder wheat (*T. compositum*, L.)

4. Dwarf or Club Wheats have been described as a species under the name *Triticum compactum*, Host. They possess short stiff straw and erect square ears, 1½ to 2 in. long, with the spikelets very closely packed on the rachis. The empty glumes resemble those of the next group (*T. vulgare*) in being keeled only in their upper halves; the flowering glumes in some varieties are awned, in others they are awnless The ears are well filled, each spikelet often ripening three or four grains, on this account these wheats frequently yield a larger amount of grain than would be expected from the size of the ears and the general appearance of the crop Dwarf wheats are among the oldest kinds, but are only grown on poor soils in somewhat remote districts

5. Common Wheats (*T. vulgare*) — To this group belong all the best wheats grown in various parts of the world for bread-corn The empty glumes are keeled only in their upper halves, the flowering glumes may be awned or beardless Hundreds of varieties are met with in cultivation, some of them are difficult to separate from forms of Macaroni wheat (*T. durum*), while others shade off into Dwarf wheat (*T. compactum*) The ancestral wild form is unknown at present

The glumes, which may be white, red, or brownish, are smooth in some varieties, while in others they are covered with velvety hairs. The straw varies in length very considerably, and the ears may be dense, with the spikelets closely set on the rachis; or lax, with spikelets arranged widely apart. intermediates are also common. The grain varies also both in colour and in quality of endosperm; it may be white, yellow, red, or brown, and soft and 'weak', or flinty and 'strong'. These characters are dependent on the variety, and upon soil and climate. Generally speaking, the varieties of Common Bread wheat grown in the temperate parts of Europe are autumn-sown and beardless, perhaps more especially those with dense compact ears and soft yellow or red grain. The economic conditions prevailing in the older countries are such as necessitate a heavy yield if the farmer is to be remunerated for his efforts; and the dense-eared forms with weak grain meet this demand. In countries with severe winters and hot summers, 'strong' varieties with low yield are grown; the majority of these are bearded varieties. High yield and 'weakness' of endosperm are undoubtedly correlated, as is 'strength' of flour and low yield, and it is not likely that very high yield and superior 'strength' can be combined in the same plant. Where high yield is a necessity to meet the demands of high rental of land and cost of cultivation, 'weak' wheats must be grown, and 'strong' varieties will ultimately disappear from the areas where they are now grown with increasing population and intensive cultivation [J. P.]

Wheat Growing in Britain

Soil and Climate — Wheat is the principal bread grain of the Western nations, and it holds an important position as a British crop. The soil and climate of Great Britain as a whole seem to suit it, for the largest number of bushels per acre and the heaviest weight per bushel are yielded by our home fields as compared with other countries British-grown wheat is nearly all mixed with Canadian or other foreign varieties to give the right proportions of milling and baking qualities for our bread eaters, but there will always be a demand for the home grown variety to make the best class of flour In spite of fluctuating markets and land laid down to grass there are still about 2,000,000 ac. grown annually in Great Britain

It thrives in all subtropical regions, and the northern limit of growth in this country may be taken at the Caledonian Canal and the Moray Firth It is essentially a heavy or clay-land crop, but will thrive on light soils, excepting on very poor ones, and always does better in a dry season

Place in Rotation — Wheat generally follows bare or half fallow, beans, clover and seeds, or roots, in the rotation It is possible for it to be planted and thrive in eight months out of the twelve, but the autumn is the best time for sowing.

The earliest drilled wheat is on bare fallow, or on a bastard fallow that has yielded peas or early potatoes In olden times the young wheat was showing above ground before the o'd crop was carted, but nowadays it is seldom drilled till the end of September or later.

The bean stubble is the next land for wheat seeding. Often this is ploughed up before the beans have been carted off. Ploughing should be done lightly, and the cultivator can be put through if there are many weeds showing up. After a one year's ley or clover, or after the root crop, the cultivations are similar and very simple If these crops have been folded with sheep, it is customary to keep the plough close up to the fold, and the drill close behind that. By the time the roots are done with, it is late in the autumn and the weather may be uncertain In northern districts the farmer may not plough up his ley till the winter, thus getting the benefit of the aftermath While the season advances it becomes necessary to allow more seed per acre. Generally speaking, the same crops that precede wheat in the rotation can follow it 'Seeds' are often sown broadcast on the wheat land and harrowed in in spring, and it makes an excellent nurse crop. In this case the self-binder is set to leave a longer stubble, and the stooks are sometimes moved to help drying and to prevent the clover seedlings being killed under them.

Autumn Work.—If the ordinary autumn wheat crop has not been got in by Christmas, there is no use putting it in till the middle of February—until indeed the 'dead' season of the year is past. All autumn-drilled wheat on heavy land requires to be surface-drained, even when there are land drains. This is done by the ordinary plough making the water furrows at suitable distances apart. The outfalls and outcast furrow slices are generally scattered over the land by hand labour. This process is often not followed with spring-sown wheat, but it may be advisable if there is a danger of a late fall of snow. Seed can often be broadcasted advantageously when the land is too sticky for the drill to work, especially after roots where it is left in distinct furrows by the plough. Wheat will stand a moist seedbed, and on heavy land will thrive if not actually puddled in. As it requires a firm seedbed it is best not to work the soil too deeply when near seedtime, and then, after seeding, to roll it to consolidate it a bit. At one time 6 pk per acre was considered sufficient seed on bare fallow, but this practice has happily died out, and at least 2 bus and up to 3 bus as the season advances is now allowed. A set of harrows may precede the drill, and should also come after to cover in the seed. Broadcasting is never practised on fallow, as there is not enough of 'cover' left in ploughing. On some soils there is a danger of making the tilth too fine, and in winter this runs into mud and forms 'winter cap', which is detrimental to growth. For this reason the land should not be harrowed or rolled too much in autumn.

If wheat has to be sown in spring- and some of the new Continental wheats suit this method—it is very necessary to be sure that it is a spring variety that is being used. Spring wheat sown in winter will adapt itself to conditions to some extent, but not vice versa. A variety of wheat brought from an earlier district often makes a beneficial change. Spring wheat does not tiller so much as winter wheat, and therefore more seed is allowed per acre, but it yields on the average the same, although it is slightly later in ripening. There is rather a diversity of opinion regarding the age of seed, but there is not much to choose from, between year-old and new seed. Of course we have all heard the fabled story regarding 'mummy' wheat found in Egyptian tombs and still retaining its germinating powers, but despite this, no one sows seed more than a year old if possible.

Spring Cultivations.—The spring cultivations of a growing crop of wheat are very simple, and consist of horse hoeing, harrowing (both with and across the rows), Cambridge rolling to prevent wireworm spreading, and perhaps harrowing again. Hand hoeing is often done, and kept on till late in spring. Wheat sown early in autumn and followed by an open winter may become 'winter proud'. This can be kept in check by allowing a flock of sheep to run over it for a few hours daily for a couple of days. Over luxuriance in the spring can also be restrained by 'flagging', or cutting off the tops of the leaves with a sickle late in spring, before the head appears. The chopped-off leaves fall on to the ground and decay, while the air and light is allowed down to the stem to strengthen it and thus minimize the danger of the crop lodging.

Manuring.—Wheat should not require much direct manuring, as it follows crops or cultivations that help to enhance the fertility of the soil; besides, it occupies the ground a much longer period than other straw crops, and should therefore readily obtain phosphates and nitrogen from the residue of preceding applications of farm yard and phosphatic manures. However, it may be advantageous to give it a dressing of dung at the time of sowing, on the fallow or stubble, or it may be spread on the young plant in spring. Artificial manures are beneficial whether applied at seedtime or as a topdressing in spring. One or two cwt. superphosphate per acre on land rich in lime—or Peruvian guano, bone meal, or basic slag on land deficient in lime—at seedtime give a good result. One cwt. nitrate of soda per acre can be applied as a topdressing in spring to make the plant come on better if it has been a hard winter, and this is especially a benefit on spring-sown wheat. 'Green' manure is often applied in the shape of rape or mustard grown on the fallow and ploughed under. Sometimes the second crop of 'mixture' grass, instead of being folded with sheep or hayed, is ploughed in. Both these forms of green manuring are supposed to circumvent the ravages of the wireworm.

Harvesting.—Cutting the wheat crop green before it is at all ripe has happily quite gone out of fashion, but on the other hand it should not be allowed to become dead-ripe, or the quality of the grain is injured by the bran getting too thick. It is necessary to exercise great discretion in deciding when the crop is ready, as this varies with the nature of the soil and season. In a hot dry year on light land and chalky soils the straw may be very thin and ripen early, really before the grain is mature. On heavy land, where the straw grows strongly, the proper time for cutting is when the straw immediately below the ear becomes yellow and will not show any sap when twisted between the fingers. Sometimes it is necessary to keep a boy to scare the birds away from the standing corn and even from the stooks. At seedtime it is possible to dispense with the bird scarer, for the grain can be treated with some of the patent bird-scaring fluids now in the market, or coal tar diluted with paraffin. 1 pt. of tar to a 4-bus. sack is a good proportion to use.

Self-binders are now almost entirely used for cutting wheat, but the side delivery with hand-tying is sometimes used when it has been a 'nurse' crop. Of course if the crop is badly lodged and storm-twisted, the oldfashioned method of the sickle and scythe has to be resorted to. It may be interesting to note that, considering all things, this method, although slower, is not so very much more costly than the modern self-binder.

It is best to have all wheat stooked or thraved the same day that it is cut; not more than twelve sheaves should be put in a stook, and six is better. These should be turned over or moved once, shortly before carting to the stack.

The sheaves should have been allowed to get quite dry before carting, or the dampness will spoil the grain. 'Seeds' grown in wheat take longer to dry, but generally in that case the binder is set to tie the sheaves smaller and looser. A light shower or heavy dew is no detriment to carting if the sheaves have been thoroughly dry before. In fact, in very hot weather in the south of England each layer on the stack is often wetted from a watering can The stacks are usually made oblong and to contain about 10 to 15 ac., which will yield 50 to 60 qr.; and this is a fair day's threshing. Thatch the stacks as soon as possible. Sometimes wheat is threshed in the field, but the sample is necessarily milky and immature, and the threshermen demand double wages during harvest time.

Cost of Harvesting.— The harvest may be 'let' to the men at so much for the whole operation or for the 'harvest month', or each operation may be bargained for and let separately. In the latter case they expect to earn as much as if paid for the 'harvest month', which is from £5 to £7 A gang of men may consist of from five to eight These work two on the stack, two or three carters, and two in the field; that is, when loading in the field there may be two pitching and two building the load Generally there is a boy, paid a small wage by the farmer, to lead the horses in the field The stacking is often done with the elevator, saving a third man on the stack; but by some its use is held to be a disadvantage, for much grain may be shed, and it entails an extra horse However, a bigger and higher stack can be put up, and this saves space and thatch. In the great wheat districts in the south of England the rates for piece work during harvest are much as follows: Chopping roads round the fields to start the self-binder is 3*d* per acre. Thus a 20 ac field costs 5*s*. to 'open up'.

Cutting with a string binder costs 1*s* 3*d*. to 2*s* per acre, not including cost of string. An acre requires a ball of string, say 4 lb more or less Two men, with their teams working in alternate shifts, with one machine will cut 10 to 16 ac. in a day. Side-delivery rates are rather less.

Tying up after side delivery, 2*s* to 2*s*. 6*d* per acre Setting up, stooking or thraving, 1*s* to 1*s* 6*d* per acre. Moving and turning the stooks, 9*d* to 1*s* per acre Carting, 4*s*. to 6*s* per acre, clearing about 10 ac. daily. Of course these rates fluctuate with the amount of crop and distance to cart it.

Thrashing.—The cost per quarter of thrashing is commonly about 1*s*. 8*d*. Even when the sample is presumably clean from the thrashing machine it requires to be dressed before being fit for market. A good sample will weigh 65 lb per imperial bushel, but lighter samples may weigh only 56 lb. The average weight of all the wheat sold in Edinburgh market for thirteen years was 62 2 lb. per bushel, while the average at Rothamsted over eight years was 61·25 lb. A farmer is well advised to sell his wheat soon after thrashing, but it can be kept stored for long periods. Some keep it stored in deep heaps without turning it, but in the dark and mixed with chaff or cavings. Others keep it in shallow heaps in the light, and frequently turn it. However, it will keep its colour better by the first-mentioned method, provided the atmosphere is not 'muggy'.

An average crop will produce 4 qr grain per acre and 30 cwt. of straw.

Diseases —Wheat is liable to several diseases, the most notable are rust and smut There is no certain remedy for the first, which is a fungoid parasite, but experiments have raised hopes that varieties that are immune will be produced.

Another fungoid disease, smut, is prevented by pickling the seed, a short time before sowing, with a solution of 'bluestone' or sulphate of copper. 1 lb. of this dissolved in 2 gal. of water will dress 1 qr. of wheat The grain is spread out on the barn floor and sprinkled with the solution from a watering can, and the heap turned over a few times so that all the seeds become wetted. It will be dry enough to sow in a few hours' time. Care must be taken that it is pure sulphate of copper that is used, for this may be extensively adulterated with sulphate of iron, which is of hardly any use for this purpose Nearly every chemist has a mixture of his own for pickling, the common one of bluestone and carbolic acid is very good. Old seed may not require pickling, as the organisms are dead, but year-old seed requires it

[P M'C]

Wheat in the Argentine

First Beginnings — Although at so early a date as 1585 wheat, grown in the then Spanish province of La Plata, was milled at the city of Cordoba, it was not until 1890 that the Argentine Republic ceased to import both wheat and flour for its local consumption At that period the improvement of the scantily grassed lands in the province of Santa Fé and Cordoba led to the system of leasing virgin land on a four or five years tenure, and encouraged wheat growing for export At first these lands were let gratis or for a barleycorn rent; but as time proceeded and the agricultural population increased, the rent (which is most frequently paid in kind) has risen to from 8 to 18 per cent of the total crop, delivered by the tenant free of all charge, at the foot of the threshing mill.

Extension and Distribution.—For some years the principal centre of wheat growing remained in the provinces of Santa Fé and Cordoba. In 1895, 64 per cent of the total area under wheat in the whole Republic was found in these two States. The benefits of agriculture, and the demand set up by an increasing number of colonists seeking land, have brought a much wider area under wheat. The risks of total loss from drought or locusts—such as occurred in the summer of 1896—have been proportionately reduced. The actual distribution of land under wheat is as follows —

Province of Buenos Ayres	6,400,000 ac.
,, ,, Cordoba	3,750,000 ,,
,, ,, Santa Fé	3,400,000 ,,
,, ,, Entre Rios	850,000 ,,
Territory of the Central Pampa	840,000 ,,
All other provinces and territories	200,000 ,,

The present wheat-growing country of the Republic extends from lat. 38° s. to lat. 28° s. and from the seaboard to as far as long 66° w. of Greenwich, or say a total region of 150 million acres. The densest area of cultivation lies between lat. 32° and 38° and between long 61° and 65°. In the Chubut Valley (lat. 43° s.) in the Patagonian territory of that name, a superior quality of wheat is grown, under irrigation, yielding 38 to 39 bus. per acre. The total area under wheat there, some 8000 ac., is, however, too insignificant meantime to deserve more than a passing notice of what may be done when the Patagonian territories are developed.

Varieties of Wheat Cultivated.—The principal type of wheat cultivated in the Argentine is a semi-hard red berry of Italian origin termed *barletta*. This wheat does well throughout the country and does not degenerate. Another Italian variety much esteemed is the Piedmontese, which is a heavy cropper. The grade produced in the Santa Fé-Cordoba zone is termed *Rofe* (an abbreviation for Rosario de Santa Fé) in the trade. Other bread wheats cultivated largely in the country are the softer Russian, Hungarian, and French varieties, best suited to the colder climate and demanding better husbandry. Quick-growing but somewhat risky crops, if summer mellows rapidly or high winds prevail at that season, are those from the Italian, Tussela, and Saldome varieties. Purple-strawed Australian wheat has been successfully introduced to the south of the province of Buenos Ayres, but the question of straw has not yet come within the purview of Argentine rural economy. In addition to all the foregoing bread wheats there is a large cultivation of hard wheat for the local manufacture of macaroni; the principal variety of this class is the *candeal*, the others being *Auchuelo* and *Tangarro*.

Cultivation.—Virgin land is usually first broken up for a catch crop of maize. Thereafter the land is ploughed with a two-share or a double-disk seat plough, to a depth seldom exceeding 4 in., and without much regard to regularity in the furrow. The disk leaves an ugly field, but breaks the soil better than the share. A fallow and second ploughing is not usual, the tilled land being crossed with a disk harrow and finished with the tines or a home-made sod-crusher or a brush. Seeding commences in May and continues until August, the quantity used varying from 45 lb. to over a bushel per acre according to season. Rolling after seeding is not practised. Seed is usually broadcasted from a 14-ft. seed-box with or without chain-harrow attachment. Drills are not in general use. No manure is spread to the land. After seeding no further cultivation is practised.

Harvesting.—This commences at the end of November in the north and finishes in January in the south. The reaper and binder is now little used in the Argentine. The header, stripping the ears and delivering into box drays for removal to the stack, is the most popular method of harvesting. The stacks are roughly built in long low piles presenting the appearance of large turnip clamps. The Australian harvester, which strips, threshes, and bags in one operation, and is drawn by horse power, is popular in the drier districts, where an evenly matured crop is available. One harvester will handle 150 to 200 ac. of wheat at an estimated cost of 4*d* per bushel found in bag.

Yield.—Throughout the Republic the yield is small as regards quantity. Losses from locusts and drought, more especially from the former, pull down the average return from the total area. A fair average on ordinary skim farming, without loss from the causes referred to, may be taken at 15 bus. As much as 35 bus. per acre have been gathered in sections of the province of Buenos Ayres. The quality of the grain is generally good, varying from 62½ to 64 lb. per bushel.

Production and Exportation.—The table on p. 141 schedules the details of these, in acres and in quarters of 8 bus.

Cost of Production.—As already stated, rent is most frequently paid in kind. At one time the rent of virgin land on a four or five years' lease, without improvements, all of which, including his house, yard, and well, are found by the tenant, did not exceed 2*s* 6*d* an acre. Rents have risen since then, and current terms when paid in cash vary from that price up to 7*s* an acre according to locality and class of land. The tenant usually occupies 250 ac. of land, which he farms with no other assistance than that of his family. The agricultural population is chiefly of Italian origin, but includes all nationalities, of which perhaps the Russians and Danes are the best farmers. Outside of his modest plant and food requirements the tenant has little expense. He works largely on credit, upon which he pays indirectly a high rate of interest through buying his goods from his creditor. The system also throws a glut of wheat on the market as soon as harvesting commences. The wheat grower practises no mixed farming, seldom even growing the cabbages for his soup. Exclusive of interest and amortisation of plant, exhausted value of soil, items of risk, casualties, and sundries, the following is the cost of production *based on an acre yielding 15 bushels*:

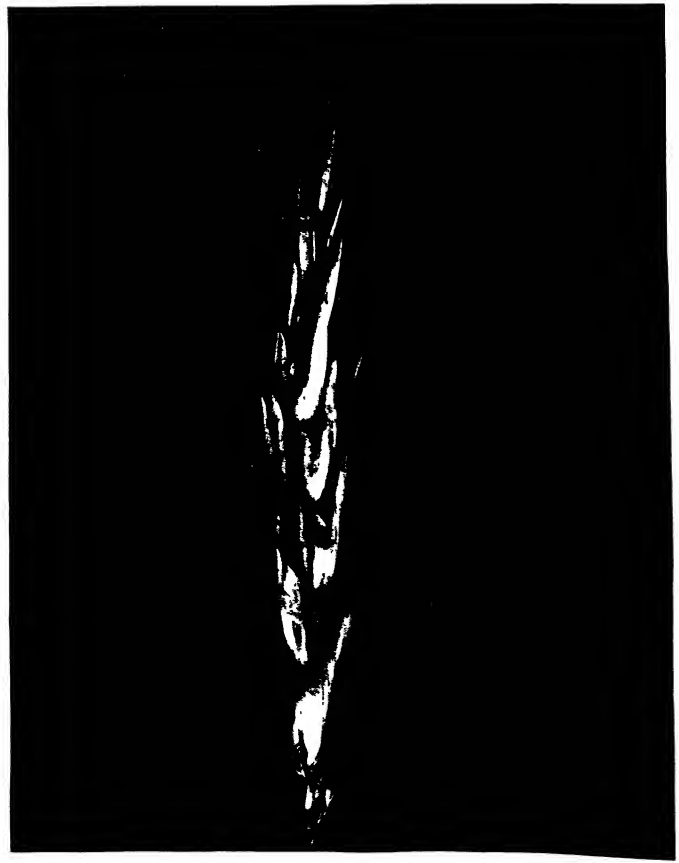
	s	*d*		*s*	*d.*
Tillage	3	8	to	4	0
Seed and curing	3	4	,,	3	6
Harvesting, threshing, and bags	13	0	,,	14	0
Haulage to railway station	3	0	,,	3	6
Rent and taxes	4	6	,,	6	6
	27	6	,,	31	6

Cost per bushel, 1*s* 10*d*. to 2*s* 3*d*.

Markets.—Of the wheat milled in the country, from 110,000 to 130,000 tons of flour are exported annually, principally to Brazil. The chief market for Argentine wheat is the United Kingdom, which takes about 46 per cent of the total quantity exported. Germany receives 30 per cent; Belgium and Holland 21 per cent, and the remaining 3 per cent finds its way to various markets.

Further Development.—The area of land available for agriculture in the Argentine is vast. It should perhaps be divided into phytological zones determined by rainfall and isotherms,

COMMON WHEAT (*Triticum vulgare*, Vill.)
Dense and awned florets



POLISH WHEAT (*Triticum Polonicum* L.)

Production						Exportation	
Year	Acres	Total Production, qrs	Bushels per acre	Home Consumption, qrs — For Milling	For Seed	Year	Quarters
1890–1	1,981,454	3,688,256	14·9	1,615,000	305,500	1891	1,726,519
1891–2	3,260,400	4,277,504	10·5	1,747,000	371,000	1892	2,051,936
1892–3	3,952,000	6,953,126	14·1	1,855,000	480,200	1893	4,531,260
1893–4	4,544,800	9,768,422	17·2	1,964,200	545,600	1894	7,019,685
1894–5	4,940,000	7,289,216	11·8	2,073,200	567,400	1895	4,409,620
1895–6	5,582,200	5,512,742	7·9	2,182,000	611,000	1896	2,322,078
1896–7	6,175,000	3,751,728	4·8	2,314,000	655,000	1897	443,533
1897–8	6,422,000	6,342,054	7·9	2,444,000	807,500	1898	2,815,098
1898–9	7,904,000	12,470,831	12·6	2,687,400	993,000	1899	7,478,774
1899–1900	8,027,500	12,075,607	12·0	2,837,000	1,032,700	1900	8 422,650
1900–1	8,347,979	8,879,915	8·5	2,902,500	1,006,800	1901	3,947,041
1901–2	8,141,284	6,697,350	6·6	2,915,700	1,129,000	1902	2,814,894
1902–3	9,127,496	12,325,540	10·8	3,009,000	1,311,200	1903	7,338,653
1903–4	10,670,400	15,447,464	11·6	3,055,400	1,440,400	1904	10,059,659
1904–5	12,130,717	17,907,029	11·8	3,099,000	1,594 500	1905	12,519,473
1905–6	14,017,974	16,028,550	9·1	3,230,000	1,789,600	1906	9,812,018
1906–7	14,059,903	18,530,453	10·5	3,537,500	1,811,400	1907	11,701,064
1907–8	14,227,167	22,867,282	12·9	3,927,900	1,876,900	1908	15,871,695
1908–9	14,391,124	18,319,066	10·2	3,972,000	1,876,000	1909	11,243,764
1909–10	14,416,278	15,380,466	8·5	4,146,500	1,898,800	1910	8,284,714
			Average,				Estimated
1910–11	15,445,354	—	10·7	—	—	1911	10,000 000

rather than into east-to-west divisions parallel to the degrees of latitude By taking the former division the zones may be described by curves running from S E to N W. The first of these, with an annual rainfall of 32 in or more, includes a portion of the province of Buenos Ayres and all that of Entre Rios. The second, lying between the isohyetal lines of 32 in to 24 in., is the wheat country proper, including the major part of the province of Buenos Ayres, Cordoba, Santa Fé, and the N E. part of the Central Pampa territory The third, between the rainfalls of 24 in and 16 in, is a belt some 80 to 150 miles wide, west of and parallel to the former, and where under proper cultivation wheat can be successfully grown. Finally there remains a great area with a rainfall from 16 in. down to *nil*, including the whole Patagonian territory and the far west of Argentina, where, until the science of water storage in the soil has achieved greater progress, wheat can only be cultivated under irrigation The resources of the latter are considerable and are being developed The temperature of the northern provinces is too high for successful wheat growing, and the cereal has already been cultivated too far in that direction

The breaking up of estates has enabled the colonists to buy small farms, encouraging settlement and a more thorough practice of agriculture. Now that experience has shown the thriftlessness of skimming the land by continuous wheat growing, the elementary principles of rotation are being recognized, and even artificial manure has begun to be sparingly employed.

[H. G.]

Wheat in Australia

Wheat is by far the most important farm crop in Australia, not only in respect of the area devoted to it, but also of its value. Of a total area under cultivation in the Australian Commonwealth approximating 12,000,000 ac., there are at present roughly 50 per cent under wheat, of which area the produce is valued in round numbers at £9,250,000. Large as these totals appear, they sink into insignificance when compared with the corresponding statistics of other countries, and in fact Australia only produces about 2 per cent of the world's wheat

The area now under wheat in Australia is, however, small relative to the area suitable and available, and while the island continent can never rank with America as a wheat producer, there is no possible doubt that as the country is developed and as settlement progresses, many millions of acres of land now only utilized for grazing will carry wheat, and Australia's quota to the world's supply will be largely increased

At present, little or no wheat is cultivated north of the 20th degree of latitude S., and by far the greater portion of the area is confined to the region south of the 25th parallel. As the essential points of difference between the cultural methods of Australia and Europe are in the main due to climatic factors, it is of importance to briefly refer to the meteorology of this part of the Commonwealth.

In general the rainfall at any point of the Australian continent diminishes with the distance from the coast Topographically the country is characterized by a range of hills of varying height, sometimes rising to 3000 to 4000 ft, which roughly speaking runs parallel to the coastal line, and at no great distance from it As might be expected, the volume of the aqueous precipitations on the shoreward slopes of this range is high relative to that on the other side of the watershed; and this so induces rust that it is impossible to grow wheat except at isolated spots in the coastal regions. Beyond the ranges, however, the country consists of undulating plains situated at varying heights above sea level, and subject to a rainfall varying from

nothing to, say, 25 in. per annum. Where the rainfall is less than about 14 in. per annum the limits of the safely cultivable area are as a rule reached, although this depends to a very great extent upon the incidence of the rainfall. In West Australia these limits are reached at a point about 200 miles inland from Perth; in New South Wales the distance from the coast is somewhat greater. There are recorded instances in Australia of 16-bus crops having been grown with only 9 in of rain between seeding and harvest; but this is only possible where the soil is so cultivated as to conserve every available drop of moisture, and where the rain comes just at the right times.

The last-mentioned factor, namely the incidence of the rainfall, is of course beyond the farmer's control, but towards the other end, namely the conservation of each drop of rain, his every operation is planned. It is for this reason that the practice of summer fallowing is now so widely adopted. When this method is followed the land can be thoroughly cleaned and pulverized by ploughing, disking, and harrowing, and reduced to such a fine tilth that when the rain does come the maximum proportion is absorbed Wheat and sheep go, so to speak, hand in hand, and on a mixed wheat and sheep farm in Australia the three years' rotation is very frequently met. The sequence follows these lines. Wheat is sown in the autumn, *i.e* about April, and harvested about the end of November Seldom is an attempt made to sow anything of the nature of sown-out grass, although occasional farmers may be found who try a small quantity of some leguminous plant, *e.g.* lucerne These cases are, however, the exception, and as a rule the 'grass' consists of the natural herbage, weeds, &c, which spring up among the stubble after the grain has been removed by the complete harvester The sheep do well on this, and the land usually remains under this 'grass' for eighteen to twenty months, when it is again ploughed and fallowed, and in due course wheat again sown Such in outline is the three years' wheat rotation. There are of necessity many modifications, and one frequently sees wheat sown on the same land year after year

Ploughing is usually shallow—to a depth of 4 to 5 in. only, nor is it on many soils advisable to go deeper. When a poor shallow soil rests on a poorer clay subsoil, it is better not to bring the clay with its poisonous unoxidized substances to the surface. On the lighter, sharper loams with good soils, 'deep' ploughing to a depth of 6 in. is advocated.

Characteristic of ploughing in Australia is the use of gang ploughs, six horses, for example, turning over three furrows This points to the want of labour, which is one very grave difficulty, and consequently every possible means of saving labour must be tried.

Another characteristic difference as compared with the home country is the general use of rotary disk ploughs and harrows. These are excellent dry-weather implements, and allow ploughing to be commenced much earlier after the removal of a crop than without them would be possible.

In sowing, the use of the combined seed and manure drill is very general; although mention must be made of a broadcasting implement which is used in districts where very large areas must be sown in limited time. In this implement the seed falls on a rapidly revolving, horizontally placed disk, from which it is widely scattered. The quantity of seed for drill sowing varies from 35 to 55 lb. per acre according to conditions. Half a bushel is usually regarded as the minimum The quantity of artificial fertilizer used is extremely small, on the average about 84 lb. superphosphate per acre. Chemically the soils of Australia are characterized by a deficiency of phosphoric acid, and extended experimenting has shown that this deficiency may be best made good by the use of superphosphate alone In most parts of Australia the optimum time for sowing is from the middle of April until the middle of May, and wheat is seldom sown earlier than the 10th of April or later than the 10th of June.

As to the varieties of wheat grown in Australia a volume might be written, and within the limits of an article such as the present it is impossible to do more than mention the names and give brief notes on the characteristics of a few of the more important. In addition to varieties introduced, or obtained by selection from introduced varieties, there are in Australia very many hybrid wheats which were originated by William Farrer, to whom is justly due the credit of being the pioneer of wheat-breeding in Australia

The following list makes no attempt at being complete, but the varieties mentioned are standard Australian wheats, and, while it is by no means easy to describe accurately any variety of wheat, the notes given are, it is believed, as true as possible

Steinwedel originated in South Australia, is a white soft wheat, drought-resistant, very early, free-stooling, prolific, liable to rust and bunt, compact habit, shells as soon as it ripens; has strong, stiff, purple-tinged straw, and large medium, plump, opaque grain A very weak flour wheat

Farmers' Friend is a Purple Straw variety derived from Red Straw. It is a strong-stooling, drought-resisting, very prolific mid-season wheat, which holds its grain well. The straw is dull-yellow or purplish, thick, stiff and strong; the grain is large, plump, white and opaque. This wheat suffers severely from rust in moist seasons and is not suited to coastal districts. Flour rather low in strength.

Australian Talavera belongs to the Lammas type. It is hardy and prolific, of medium height, free-stooling, and drought- and cold-resistant. The strongest of the soft wheats.

White Lammas, a late mid-season variety of tall growth. The straw is white, strong and supple; the grain large, long, and plump, and gives a fairly strong flour

Non Pareil is a mid-season wheat of medium height, which does not resist drought well. The straw is bright, clean, yellow-coloured, and fairly tough; the grain is medium-sized, plump, and fairly hard.

White Essex is a late mid-season wheat of the Lammas type, free-stooling and of tall growth. The straw is stout, stiff, tough, and white, and the grain large, long, soft, white, and plump, yielding a flour low in strength, but high in gluten.

Zealand or *Berthoud* belongs to the same group as the preceding. It does not stool freely, and is drought-resistant. The straw is long, flexible, and fairly strong. The grain is plump, very large, and long. Milled it gives a weak flour rich in gluten

Dart's Imperial is a variety of the Purple Straw type, and originated in South Australia It is rust liable, resists drought, and does well in hot districts. Of compact habit, the straw is tall, stiff, and strong, while the grain is medium-sized, plump, white, and soft.

White Hogan, a late variety, fairly prolific, does not resist drought well, and has a tendency to shell. Grain large and long, and yields a very weak flour.

Marshall's No. 3 is a variety derived from Ward's Prolific. It is rust-resistant, and is a fairly prolific, late mid-season wheat. The flour is of fairly high strength and is rich in gluten.

Reference must now be made to the late Mr. Farrer's cross-bred wheats, of which many varieties are now popular and widely cultivated. For many years this scientist laboured quietly, unostentatiously, and with marked success at the improvement of Australian wheats. Among the best-known of his varieties are the following:—

Federation is a successful cross between Purple Straw and Mr. Farrer's Fife Indian wheats. It is early ripening, drought-resisting, prolific, and holds its grain well. The grain is large, white, and soft, and the flour of much greater strength than the Purple Straws.

Among other varieties of improved soft weak flour wheats bred by Mr Farrer may be mentioned Jade, Cumberland, Cleveland, Rymer, Plover, and Schneider.

Bobs is a variety resulting from a cross between a spelt from Blount's Lambrigg and Bald Skinless Barley. It is very resistant to drought and rust, and has a tendency to shell. The habit of growth is tall and the straw fine. The grain is small, plump, white, hard, and translucent A splendid milling wheat, giving a good proportion of strong flour.

Jonathan, *John Brown*, and *Tarragon* are among the most successful of the late Mr. Farrer's strong-flour cross-bred wheats. Jonathan is characterized by its power of resisting rust, by its very fine, rather weak, and long straw. It is a quick grower and a good drought resister.

There remain now only the methods of harvesting and the yields to be considered. The crop is sometimes cut with an ordinary reaper and binder—necessarily so if, as is frequently done, it is to be made into 'hay'. 'Hay', it may be mentioned, in the Australian acceptation of the term consists of the straw with grain attached of such cereals as wheat and oats. If a wheat crop promises to give such a poor yield of grain as not to be worth harvesting, the farmer usually makes it into hay.

By far the more common practice, however, is to harvest the grain only by means of either the 'stripper' or the 'complete harvester'. The 'stripper' is purely an Australian invention, restricted in its application to certain climatic conditions. It is a machine drawn through the ripe standing crop by three or four horses yoked at the side. The ripe ears are guided to a cutting plate by a comb and cut from the straw by a beater drum, which thrashes the grain out and delivers it with the chaff and a small quantity of straw into a box of about 8 bus. capacity. This box is emptied at a winnowing machine situated in any convenient part of the field, where the grain is winnowed, cleaned, and bagged

The 'complete harvester' is an improved stripper in which the thrashed but uncleaned grain is delivered into a winnowing attachment and there cleaned This implement, therefore, harvests the ears, thrashes the grain, winnows and bags it ready for market, and very considerably reduces the cost of harvesting

The yields of wheat in Australia vary so widely that average figures must be accepted with reservations. In some parts of South Australia, for example, and during certain seasons, large areas put in give no yield at all, and this very seriously reduces the average for that State The average yield of wheat per acre in New South Wales during the past decade may be given as from 9½ to 11 bus per acre In South Australia the average, for reasons already given, is still lower (about 8 bus.).

How, then, it may be asked, does wheat-growing pay? For the simple reason that the cost of production is correspondingly low. In the very dry districts it is estimated that an 8-bus crop sold at 2*s* 6*d* per bushel will pay the farmer.

Actual figures of the costs of growing wheat on large farms in districts of less than 20 in mean annual rainfall have shown that the crop can be put in and taken off for 21*s*. to 23*s* per acre yielding 12 bus. Figures supplied by another large wheat grower show that his costs ranged from 30*s* to 31*s*. 6*d*. (approximately) per acre for 15-bus crops.

The market rates on the farm in Australia usually run from 1*s* 1*d* to 1*s* 3*d* per bushel lower than the values ruling in Mark Lane.

[J. M H.]

Wheat in Canada

The rapid development of wheat-growing in Canada is reflected in the following statistics. In 1871, 1,646,781 ac. were given up to wheat, and 16,723,873 bus. produced In 1908, the corresponding returns were 6,610,300 ac and 112,434,000 bus. In 1903 the export trade in wheat was valued at $24,566,703; in 1908, at $40,004,723.

Varieties.—In Canada, as in other countries, no one variety holds sway, and there is carried out at the various Government Experimental Farms experiments and tests with old and new varieties under varying conditions of cultivation, in order to obtain the best possible results.

Of Spring wheats, the following varieties have been tried Preston, Red Fife (there are a number of strains of Red Fife grown), White Fife,

Huron, Pringle's, Champlain, Stanley, Percy, White Russian, Red Fern, Chelsea, Marquis, Bishop, Riga, Hungarian White, Minnesota 188, Yellow Cross, Yellow Queen, Spence's Yellow, Prospect, Gatineau, Early Russian, Outlook, Bobs. Of the Macaroni or Durum varieties, which are also Spring wheats, there are the Goose, Roumanian, Mahmondi, Beloturka, Kubanka, and Yellow Gharnovka. Of the varieties quoted, Red Fife (beardless) has been grown more extensively than any of the others, but is now being superseded by some of the newer varieties on account of their earlier maturing qualities, and being almost equal in flour-producing value, also giving a heavier yield

Of the newer varieties giving possibly the best results taking the country as a whole the Marquis, Bishop, Stanley, and Chelsea (beardless), Huron and Preston (bearded), are some of the leading varieties It does not, however, hold that a variety giving the most satisfactory results in one part of the Dominion may meet with favour or give good results in other localities For instance, in experiments in Nova Scotia White Russian has given the heaviest yield, but in Ontario Bishop A is the leader in that respect In Manitoba Marquis holds the premier place, but in Saskatchewan Huron and White Fife are the leaders In Alberta and British Columbia Chelsea is the best variety In one respect, however, the various localities are similar, and that is in the amount of seed used, and the time of sowing and harvesting

Among the varieties of Fall or Winter wheat that have been tried are Turkey Red, Kharkov, Abundance, Early Windsor, Prosperity, Red Velvet Chaff, Reliable, Dawson's Golden Chaff, Red Chief, Gold Coin, Silver Sheaf, Tasmania Red, Imperial Amber, Egyptian Amber, Early Red Clawson, Invincible, Jones's Winter Fife, and American Banner Ontario and Alberta are the two provinces where Winter wheat is grown to any extent, and in Ontario Dawson's Golden Chaff has been the leader, while in Alberta Turkey Red—or as it is now known, Alberta Red- is proving to be one of the best varieties known, both as to yield and in flour-producing qualities [M M'I]

Though wheat is grown in nearly every province from the eastern to the western seaboard of Canada, the great wheat belt is the western prairie According to the Report of the Scottish Commission on Agriculture to Canada—from which the statements in this section have been largely drawn—the physical features and the soil conditions within this vast area are somewhat varied. The typical prairie is flat and treeless, the monotonous levelness being broken only by the scattered homesteads of the settlers. Then there is the rolling prairie, gently undulating in character, and the prairie of scrub and light timber - the so-called 'park lands'. The soil of the prairie is equally varied, from a rich black loam to a light sand, from wet to dry and semi-arid. The climatic conditions are much more even; the temperature in summer rises to 100° F., and in winter falls to 40–45° below zero. Unhappily, the rainfall over a wide part of this great and fertile region is limited, and for success in wheat-growing every effort must be made to conserve all the moisture that falls during the rainy season

Out west, such a thing as rotation of crops is unknown, or at any rate unpractised The process adopted by the settlers is to take two or three crops of wheat in succession, to fallow the land for a year, and then to revert to wheat Such a system of farming must necessarily end in soil exhaustion; but the present-day settler recks not of the distant future, resting secure in the reflection that the fertility of the prairie will at least last his generation

Both fall wheat and spring wheat are grown on the prairie The raising of fall wheat is confined mainly to the semi-arid regions of Southern Alberta Over this area the soft Chinook wind blows, making the winter more open and the temperature less extreme than that of the other provinces Consequently, although the precipitation is small, the comparative mildness of the winter, the adoption of hardy wheats like the 'Alberta Red', and the careful conservation of the moisture by fallowing every alternate year, have made fall wheat an economic success The seed is sown on prepared land in July or August. By the end of autumn the wheat will have grown to 6 to 8 in high It occupies the ground for a whole year, and gives a heavier crop than spring-sown wheat, because the plants are more deep-rooted and can better exploit the soil in search of food and water. Fall wheat ripens a fortnight earlier than spring wheat, and has thus a better chance of escaping the autumn frosts From 40 to 50 bus wheat have been obtained from fall wheat in the Cardston district of South Alberta

The bulk of the prairie wheat, however, is spring-sown Before breaking in the virgin soil, the grass is burnt and stones and boulders removed or buried deeply Breaking must be done in spring before the rainy season sets in Success in wheat-growing depends on the water content of the soil, and when the land is reduced to a good tilth early in the year, it conserves all the available moisture that falls during the wet season June is the rainy month, and if breaking were postponed till the fall, the soil would not gather enough moisture to meet the requirements of next season's crop In breaking, the gang or sulky plough, fitted with a sod bottom, is used After the rainy season, during July and at intervals during the fall, the land is disked and harrowed until a fine surface is obtained. The cost of these preliminary operations is approximately as follows Breaking, $3 50, disking, $1 75; harrowing, $·70. Total, $5 95 The land is then left untouched till spring. During the winter the frost is severe, penetrating the ground for 5 to 6 ft and opening up and pulverizing the soil. No difficulty is experienced at seedtime, but it is of vital importance to get the seed sown as soon as the frost is out of the ground. It is sown at the rate of 1½ to 2 bus per acre, from 10th April to 1st June. by means of a grain drill, usually drawn

by four horses covering 15 to 20 ac. a day After seeding, the soil is rolled or 'planked' From 112 to 120 days after being sown, the wheat is ready for cutting. Harvesting begins about the end of August. The grain is usually cut before it is golden and dead ripe, otherwise the high winds which prevail at this time of the year would result in a large loss of grain. The cutting is done with the ordinary binder drawn by four horses and fitted with an 8-ft cutter bar The binders, which leave a long stubble, are furnished with carriers and discharge six sheaves at a time. The sheaves are set up in rough stooks or shocks, and it requires a good man to stook to each binder Threshing begins as soon as the grain is all stooked, sometimes indeed threshing and stooking proceed simultaneously on the same holding. Threshing is mostly done in the field The stooks are pitched on to light wagons drawn by two horses and brought to the mill The threshing machine has a self feeding device, and is fitted with revolving knives which cut the binder twine Two wagons discharge their loads into the thresher at a time The straw, cut by the revolving knives, is blown out along with the chaff through a long spout by means of a strong air blast, and collects in a large bing which is afterwards burnt The grain as it comes from the mill is automatically weighed, and discharged in bulk into wagons waiting to receive it. It is then either taken to the railway station to be dispatched to the market, or sent to the nearest elevator Everything is done with the minimum of labour The mill itself, which threshes out from 1200 to 1500 bus per day, is operated by an engineer and fireman Two teamsters, one on each side of the mill, fork the loads from the wagons which bring in the stooks, and keep the mill going merrily When the mill-owner provides the engineer, fireman, and four forkers, 4 cents per bus are charged for threshing, or 7 cents when he provides all the labour save that of conveying the grain to the railway elevator

The expense of seeding, harvesting, and threshing the first crop of wheat amounts on an average to $4 18 per acre. Add to this the cost of bringing the prairie into cultivation ($5 95), and we see that the total expense of the first crop runs up to $10 13

The labour bill for the second year's crop of wheat is much smaller. After harvest, the land is left untouched till spring. The stubble, which has been left long to gather the snow, is then burnt, and the land simply disked and harrowed prior to seeding The total cost may be put at $6 33

If we estimate the average yield at 19 bus per acre, and 80 cents as the price which the farmer gets for his wheat, we conclude that a profit of $4 77 per acre is realized on the first year's crop, and $8·87 on the second year's crop From this apparent profit, however, we must deduct the interest on capital invested in land and stock, the cost of fencing, fallowing the third year, the keep of the men and horses in those seasons when no work is done, and the loss through drought and frost. Yet, taking all these factors into consideration, the average gain to the farmer is not inconsiderable There is a great chance for the man with small means, but a much bigger chance for the man with capital and brains.

Grading and Marketing the Grain – Canadian wheat is sold according to grade The factors which influence grade are plumpness, mellowness, ripeness, absence of smut, and whether the grain has been frozen or not before being cut The grade is fixed by government inspection at Winnipeg The chief grades are No 1 Manitoba Hard, No 1 Manitoba Northern, No 2 Manitoba Northern, No 3 Manitoba Northern, Commercial Grade No 4, Commercial Grade No 5, Commercial Grade No 6, and Commercial Grade Feed The finer grades of Canadian wheat are of unexcelled quality, fetching on an average 2*s* a quarter more than the Kansas and Russian Hard winter wheats, and 6*s* a quarter more than the best English wheat, which is deficient in strength From Winnipeg the grain passes on to Fort-William, the centre of the export trade. Here the grain is finally weighed The farmer may either dispose of his wheat to one of the elevator companies, who grade it and pay him for the grain as he delivers it by the load, or he may ship it on the rail to Winnipeg, receiving payment on the basis of Winnipeg inspection and Fort-William weights. The nearer the farmer is to the railhead the less is the cost of transport, and the sooner can the grain be put on the market Nearness to the metals is of vital importance, for if the farmer be working shorthanded or with insufficient teams, the transport of the grain over the heavy prairie trail may use up much valuable time that should be given to the preparation of the land for next season's crop

The chief drawbacks to the Canadian wheat grower are—the prevalence of smut, which lowers the yield and the value of the grain, the danger from hail in August, which sometimes destroys his whole crop, and the visitation of early autumn frosts While the farmer has no control over the weather conditions, he can easily check the loss from smut by treating the seed with formalin. [R. H. L.]

Wheat in India

Area and Distribution—On an average of the five years 1905–9 the estimated area under wheat in India was close on 28,000,000 ac This, however, is only an approximate figure, for the district crop returns, especially those from the native States, on which the estimate is based are untrustworthy, and a further obstacle to accuracy is found in the fact that wheat is very commonly grown with subordinate mixtures of pulses or oilseeds or both It ranks second in importance among the crops of India, rice with an estimated area of some 70,000,000 ac being an easy first The area under wheat varies somewhat from year to year, the chief conditioning circumstance being the extent of the rainfall in the six or eight weeks (September–October) immediately preceding the sowing season Except for this slight variation the area remains fairly constant, and the only hope of

any considerable expansion lies in the construction of new irrigation works

Wheat is grown in all the provinces of India, but principally in the north-western portion of the Indo-Gangetic plain and in the Central Provinces, Central India, and Bombay Of the total area the Punjab supplies 37 per cent, the United Provinces 23·9 per cent, the Central Provinces 12 per cent, Central India 7·3 per cent, Bombay 6·5 per cent, and Bengal 4·4 per cent The growing period of the crop varies greatly with the latitude Sowing takes place in October and early November, but while harvesting operations begin in the Central Provinces and Bombay in the month of February, they are not completed in the North-West Frontier Province until the latter half of May With the onset of the hot weather the crop ripens very rapidly, especially if soil moisture is deficient

Irrigation About 35 per cent of the total wheat area in India is under irrigation, in whole or in part. Irrigation water is supplied from the splendid system of canals which tap the waters of the Indus and the Ganges, but also to a very large extent from wells, and sometimes from basins where the water is impounded in the rainy season Frequently also the monsoon rainfall is embanked in the fields to be occupied by wheat in the following cold season In the arid districts of the Western Punjab commanded by flow irrigation from canals, wheat is grown from start to finish on irrigation alone, while in other districts, such as the United Provinces and Eastern Punjab, irrigation is used to supplement the natural rainfall, which in the growing period of the crop is seldom more than 2 to 3 in, and frequently is a negligible quantity Irrigation from wells is a laborious process The water lifts employed are usually either the Persian wheel, where the water in the wells is comparatively near the surface, or for greater depths the leather bag, the lifts in each case being almost universally actuated by bullock power A good well will irrigate about an acre in a day.

Varieties Grown. — A great many varieties of wheat, designated by vernacular names, are grown. These so-called varieties, however, invariably consist of mixtures of several distinct botanical forms These forms in general are varieties of *Triticum vulgare* (common wheat), but varieties of *Triticum compactum* (Dwarf wheat) and *Triticum durum* (Macaroni wheat) are grown on considerable areas, and *Triticum spelta* (Spelt wheat) is also found. The grain may be classed into hard and soft red, and hard and soft white or yellow, but hardness and softness are not altogether permanent characters, varying with the locality in which a particular variety is grown, and to some extent with the season. The wheats grown are almost invariably bearded.

Little has been done so far in India in the improvement of varieties by breeding or selection. The agricultural experiment stations have now such work in hand. Exotic varieties have been introduced from time to time, but with scant success, as the growing period is usually too short to allow them to mature.

Soils and Cultivation — In the Indo-Gangetic plain, wheat is grown on deep medium to clayey loams of alluvial origin, some of which, under proper cultivation, have remarkable powers of retaining their soil moisture; in Bombay and the Central Provinces mainly on the retentive 'black cotton' soil. Irrigated wheat may be grown on lighter soils The preparatory cultivation is usually of a careful character Land destined for dry crop wheat generally lies fallow during the preceding hot weather and monsoon, and is frequently ploughed or scarified during that period The implement chiefly used is the common wooden plough, but on the black cotton soils a simple iron bullock hoe or scarifier frequently replaces the plough. Towards the end of the monsoon every effort is concentrated on conserving the moisture in the soil The land is worked down to a fine tilth, cleared of weeds, and finally consolidated with a plank roller grooved on the under side, and weighted by either one or two drivers standing on it It is then left until the weather is cool enough for sowing, but if any rain falls in the interval the soil is again stirred and consolidated as before This method of 'dry farming', of which so much has been heard in recent years in America and elsewhere, has been the normal method of cultivation in India for ages The Indian cultivator, to whom the moisture supply of the crop is always the prime consideration, thoroughly understands the principles involved, but he is handicapped somewhat in his practice by the primitive nature of the tillage implements at his disposal. Land ploughed to a depth of 3 to 4 in, which is about the limit of the common wooden plough, gives neither the water storage capacity nor the seedbed afforded by land cultivated to twice that depth, nor is the light plank roller an efficient pulverizer or consolidator, but the holding of the average Indian cultivator is very small, and his financial resources do not permit of his purchasing expensive implements, nor indeed would the cattle which his small holding supports be strong enough to draw them But with the cultivation given, and a winter rainfall of 2 to 3 in. distributed over December and January, a fair crop is ensured. In the districts where wheat is grown wholly on flow irrigation there is, as a rule, little cultivation done until shortly before seedtime A preliminary watering is given to soften the land for ploughing, unless the monsoon has previously provided enough for this purpose When the necessary cultivation has been completed the land receives a heavy watering, after which sowing is done, and further waterings, four to six, are given until the crop approaches maturity. On irrigated land the seed is usually broadcasted Dry crop wheat is sometimes drilled in with a two-tined country drill, but much more frequently it is sown broadcast, or if moisture is deficient, sown in the furrows behind the plough. The seed rate for drilled wheat is 40 to 60 lb, that for broadcasted wheat 60 to 100 lb. per acre, according to the moisture.

The wheat crop receives, as a rule, little or no manure. It is frequently grown mixed with

pulses or oilseeds such as safflower, linseed, mustard or rape; in fact, only irrigated wheat is ordinarily grown as a pure crop. The main idea underlying this practice is that of insurance. If the winter rains are good the wheat crowds out, to some extent, the other constituents of the mixture; if deficient, the latter do relatively better. Wheat is sometimes grown continuously on the same land, but usually it is rotated with some or other of the many crops grown, the importance of leguminous crops (of which there is a great variety) in the rotation being fully understood.

Harvesting is done by means of a small sawedged sickle or simply by uprooting. Of late years there has been some introduction of reaping machines into the recently settled canal areas where labour is scarce, but ordinarily the reaper cannot compete with manual labour. A few days after harvesting, the crop is carried to the threshing floor and the grain trodden out by cattle, the straw being at the same time converted into a short, soft chaff which much enhances its value as a fodder. The grain is winnowed by the hot winds which commonly blow at this season.

Diseases.—In some years wheat is greatly damaged by rust, of which three distinct species, *Puccinia graminis* (Black Rust), *Puccinia glumarum* (Yellow Rust), and *Puccinia triticina* (Orange Rust) attack the crop. The damage caused by rust in bad years has been estimated at not less than 10 per cent of the total yield. The chief condition which seems to favour a severe epidemic is damp and cloudy weather in the months of January and February, when the crop is in ear. Spelt wheat is said to be rustproof, but when grown away from its ordinary locality does not prove so. The experience with rustproof wheats introduced from Australia has been similar. Smut is common in most Indian wheatfields.

Production and Export. The total wheat production of India on an average of the last seven years is estimated at 8,410,000 tons, which gives an average of about 11 bus. the acre. On fully irrigated land an average yield is about 32 bus., while a good dry crop seldom yields more than 16 bus. In the local markets a bushel of 60 lb. will fetch in normal years about three shillings. The exports in 1909-10 to foreign countries were 1,050,574 tons, the highest figure recorded so far. Mostly soft wheats are exported, these being heavier yielders and consequently more in favour in the districts from which the exports are chiefly drawn. Hard wheats are preferred for native consumption. [G. S.]

Wheat in the United States

Statistics.—In bulk production, wheat stands third in rank among the cereal crops of the United States. Reckoning the production by weight, however, and considering the farm value of each crop, it easily ranks second, oats being far the closest competitor.

In 1909 the oat production was, in round numbers, 1,007,000,000 bus., and that of wheat 737,000,000 bus. The actual weight of each crop was 32,000,000,000 lb. of oats and 44,000,000,000 lb. of wheat, while the farm value of each, December 1, was $408,000,000 for oats, compared with $730,000,000 for wheat. Corn (maize) ranks much the highest, the farm value of that crop being $1,653,000,000 in 1909.

Wheat production has steadily increased in the United States, but not so rapidly in recent years as formerly. There is at present a distinct tendency toward expansion. The acreage, yield per acre, production, farm price per bushel December 1 of each year, total farm value December 1, export (including flour), and percentage of crop exported for the past decade, 1900–1909, are as follows. Flour is reckoned at 4½ bus. of wheat to the barrel of flour.

Year	Acres	Yield (bushels per acre)	Production (bushels)	Farm Price per Bushel (cents), Dec. 1	Farm Value Dec. 1	Export including flour (bushels)	Per cent of Crop exported	Per cent of export in form of Flour
1900	42,495,385	12·3	522,229,505	61·9	$323,515,177	215,990,073	41·4	45·14
1901	49,895,514	15·0	748,460,218	62·4	467,350,156	234,772,516	31·4	38·77
1902	46,202,124	14·5	670,063,008	63·0	422,224,117	202,905,598	30·3	34·03
1903	49,464,967	12·9	637,821,835	69·5	443,024,826	120,727,613	18·9	43·46
1904	44,074,875	12·5	552,399,517	92·4	510,489,874	44,112,910	8·0	63·11
1905	47,854,079	14·5	692,979,489	74·8	518,372,727	97,609,007	14·1	88·89
1906	47,305,829	15·5	735,260,970	66·7	490,332,760	146,700,425	20·0	64·15
1907	45,211,000	14·0	634,087,000	87·4	554,437,000	163,043,669	25·7	47·62
1908	47,557,000	14·0	664,602,000	92·8	616,826,000			38·57
1909	46,725,000	15·8	737,189,000	100·5	730,046,000			

These figures are reported by the Bureau of Statistics, U.S. Department of Agriculture.

The yield per acre of wheat in the United States is small, though larger than that of some other wheat countries. The average is now about 14 bus. A close inspection of the statistics shows that there has been an increase in acre yields of 1½ bus. in the past forty years, a large part of which increase has occurred in recent years.

The United States has so far stood at the head of all countries in wheat production. European Russia grew almost as large a crop in 1909 (711,000,000 bus.), and once, in 1904, exceeded the United States. Russia is also a close competitor of the United States in wheat exports, including flour, though the average for the latter is a little greater than that of the former. As shown in the table, the percentage of the crop exported from the United States is much less

in recent years than formerly. This condition has been caused partly by a less rapid increase in annual production, and apparently also by a considerable increase in per capita consumption at home

The flour manufacture of the United States is of great magnitude and importance, and the flour export much the largest in the world The value of all flour-mill products was $505,000,000 in 1880, and increased to $713,000,000 in 1905 The flour export averaged over 14,000,000 barrels during the period 1903-07, and was nine times greater than that of Canada, the next greatest flour-exporting country

Adaptation and Distribution — The climate of the United States is continental, and hence, in large part, subject to extreme changes Along the coast it is, of course, considerably tempered by the influence of the ocean, particularly on the Pacific side The soil formation also is extremely variable, depending upon the district where it occurs, whether it is plain, forest, a large river valley, or mountainous area As would be expected, therefore, there are also great differences in the characteristics of the wheat varieties that do best in different parts of the country

The country is, to a large extent, very similar to Russia (in Europe), and over a large portion, certain States or small districts appear to be exactly parallel to corresponding districts in Russia in the nature of both soil and climate. So, the kinds of wheat adapted to these corresponding districts are about the same in the two countries. In fact, some of the principal varieties of most commercial importance, such as the Fife, Hard Winter, and Durum, were introduced from Russia into the United States

Wheat Districts With respect to the wheat varieties best adapted, the United States may be considered as divided into eight wheat districts as follows. (1) The Soft wheat district, including mainly the New England and Middle States, (2) the Semi-hard Winter wheat district, including the north Central States, Ohio, Indiana, Illinois, Michigan, and southern Wisconsin, (3) the Southern wheat district, including the northern part of the southern States, that is, north to the Ohio River, (4) the Hard Spring wheat district, including the northern States of the Plains west to the 100th meridian, (5) the Hard Winter wheat district, including the Middle States of the Plains west to the same meridian; (6) the Durum wheat district, including all the Great Plains between Canada and Mexico and from the 100th meridian west to the Rocky Mountains, (7) the Irrigated wheat district, including, in general, the scattered portions of the Rocky Mountain and Basin States, where wheat is usually irrigated; and (8) the White wheat district, including the Pacific Coast States. In the first of these districts soft-grained wheats are grown, generally winter varieties, but some spring seeding is done in northern New York and New England They may be bearded or beardless, are usually red-grained, but there are some white varieties Some of the principal varieties are Fultz, Jones's Winter Fife, Gold Coin, Fulcaster, Dawson's Golden Chaff, Early Red Clawson, and Deitz. Nearly all the wheat of the entire district is grown in New York, Pennsylvania, and Maryland

The Semi-hard Winter wheat district produces a wheat of medium quality, and is one of the important cereal regions The varieties grown are generally semi-hard, either bearded or beardless, and have usually a reddish kernel There is a distinct tendency constantly toward the use of harder red wheats The proportion of hard wheat now grown in this district is much greater than twenty years ago Similarly there has been a rapid increase in the proportion of winter to spring wheat, so much so, that at present very little spring wheat is grown The chief varieties in use are Fultz, Rudy, Poole, Valley, Dawson's Golden Chaff, Budapest, and, in some localities, a considerable amount of Turkey

In the Southern wheat district the annual wheat production is comparatively small, and is furnished principally by Kentucky, Tennessee, Virginia, and southern Missouri The wheats are either soft or semi-hard, and have a reddish or amber kernel. Because of the damp, warm climate there is often considerable rust on the wheat Some of the important varieties grown are Poole, Fulcaster, Fultz, Red May, Currell's Prolific, and Purple Straw.

The Hard Spring wheat district includes Minnesota and portions of Wisconsin, Iowa, North Dakota, South Dakota, and Nebraska In this district, because of the rich black soil and dry hot summers, there is grown the highest grade of spring wheat in the world, except the spring wheats of the middle Volga region in Russia, which are very similar Two types of wheat prevail generally — the Velvet Blue Stem and the Fife. The chaff of the former is covered closely with small hairs, and the plants are bluish-grey near harvest time In both types the heads are beardless, and the kernels are medium or small, hard, and red There are several strains of each type The gluten content of these wheats is very large, and the quality such as gives great lightness in bread-making. The largest flour mills in the world are at Minneapolis in this district The average annual wheat production of this district is larger than that of any other similar area in the world, and is about 30 per cent of the entire production of the United States The average yield per acre, however, is very small

The Hard Winter wheat district includes approximately nearly all of Kansas, northern Missouri, southern Iowa, and Nebraska to the 100th meridian, all of Oklahoma to the same meridian, and northern Texas. As the name implies, it is characterized by the production of Hard Winter wheats of the best quality, corresponding in this respect, somewhat, to the Hard Spring wheat district. The only other district in the world that exactly parallels this one is that including the Crimea and North Caucasus in Russia The wheats have slender, stiff stems, narrow, compact heads, are usually bearded, and have medium or small hard red grains. These wheats are extremely hardy, and must be so, as the great severity of the drought and winter-

cold combined forms a greater obstacle to winter-wheat growing than exists in any other district. The soil in this district is a deep black loam, of the nature to produce wheats having a high gluten content. Nearly one-fourth of the entire wheat production of the country is grown in this district, Kansas alone furnishing about one-eighth. The principal varieties grown are Turkey (or Crimean), Kharkov, Mediterranean, Fulcaster, and Fultz.

The Durum wheat district is a comparatively narrow belt extending entirely across the country north and south, including all the arid and semi-arid portion of the Great Plains. The conditions are extremely severe, and only the most drought-resistant wheats can be grown with any success. The Durum wheats have so far been found much the best adapted varieties. Until the introduction of these wheats from Russia by the U.S. Department of Agriculture about the year 1900, very little effort was made to grow wheat in this area. Now, about 50,000,000 bus. of Durum wheat are produced annually. Durum wheats are tall, have wide leaves with a harsh surface, and large heavy-bearded heads, compactly formed. The kernels are very large and long, and yellowish-white or amber in colour, becoming darker the blacker the soil in which they are grown. They are the hardest wheats known. Contrary to a common opinion previously held, these wheats make excellent bread, as well as being the only wheats well adapted for macaroni. They not only resist drought, but are also highly immune to rust. The chief varieties grown in this district are Kubanka, Arnautka, Nicaragua (all Durums), and also a considerable amount of Turkey and Kharkov in the southern portion of the belt.

In the Irrigated wheat district, as the name implies, wheat is usually grown under irrigation, though in recent years, in a number of localities, 'dry farming', that is, farming without irrigation, has been attempted. The States included are Wyoming, a part of Montana, southern Idaho, Utah, Nevada, Arizona, New Mexico, and western Colorado. Besides dryness there are two other important characteristics of this district: (1) a very low humus content, and (2) a superabundance of alkali in the soil. Because of the practice of irrigation and the lack of soil humus, the wheats are usually white, soft, and starchy. Some of the chief varieties grown are Defiance, Little Club, Sonora, Taos, Kofford, and more recently a considerable amount of Turkey.

The White wheat or Pacific Coast district includes particularly California, Oregon, Washington, and northern Idaho. All wheat varieties that have become acclimated are characteristically soft, starchy, and white, yellowish or light amber in colour. There is much variation in these qualities, however, in different localities, and depending upon the variety. There is a much larger proportion of the club wheats in this district than in any other. The principal varieties in California are Australian, California Club, and Sonora. In the northern portion of the district they are Palouse, Blue Stem, Red Chaff, Little Club, Jones's Fife, and Red Russian.

Wheat Improvement.—Although the United States is important as a wheat country, being even yet comparatively new there has not been as much progress in the improvement of wheat as in many other countries. Of course, all varieties had, some time, to be obtained from other regions, as there is no strictly native wheat. Naturally, therefore, much of the improvement has resulted from the introduction of new varieties from other parts of the world, that are soon found to be much better adapted to certain portions of the country than the varieties previously grown. Actually a great deal of improvement has been made in this way.

Among the introductions made some time ago that were of great value, was that of the variety Mediterranean, so called from having been obtained from the region near the Mediterranean Sea. This variety was first introduced into the eastern States about the year 1819, but afterwards was found to be so valuable that it was established as probably the most important wheat in northern Texas and adjacent localities. Another introduction, and probably the most important one made until recent times, was that of the Fife wheat into the northern States of the Plains. This wheat came directly from Canada, but was brought, by Mr. David Fife of that country, from Scotland, and was originally obtained in a cargo of wheat shipped from the Baltic Sea. As it much resembles some of the common Russian wheat along the Volga River valley, it is probable that it was first grown in Russia. The introduction of this variety was practically the foundation of the entire present production of Hard Spring wheat of excellent quality in the northern Great Plains.

Soon after the year 1870 the Russian Mennonites brought to Kansas from the Crimea a variety of hardy winter wheat. It is bearded with red chaff and has a very hard red kernel. This wheat in turn was the foundation of the present important wheat industry of the middle Great Plains, including Kansas and adjacent territory.

The most recent introduction that has had considerable effect on the wheat industry of the country in general, and that has added much to the farm value of the wheat crop, is that of the Durum wheat from east Russia. This was obtained in 1900, and the production has increased rapidly from about 150,000 bus. in 1902 to the present production of somewhere near 50,000,000 bus. A considerable quantity of the present wheat export is of this variety, amounting to about 20,000,000 bus. annually. A matter of great importance about its introduction is that it is successfully grown in very dry districts where wheat cultivation with other varieties would usually be impossible.

Selection and cross-breeding are comparatively recent methods of wheat improvement in the United States, but within the past twenty-five years considerable progress in these lines has been made. Some of the best results have been accomplished by Professor W. M. Hays, in the production of better yielding sorts at the Minnesota Experiment Station, and by A. N.

Jones, in the development of a number of good strains from wheat crosses in New York.

Wheat Cultivation.—As to general features, the practices in wheat cultivation, harvesting, &c., in the United States are rather similar to those employed in Russia, Hungary, Argentina, and Australia, all those regions having also conditions of soil and climate somewhat similar. However, as in the matter of the adaptation of wheat varieties so in cultivation methods, practices vary a great deal in different portions of the country, because of the difference in conditions. In the eastern and southern States and the States north of the Ohio River the systems of cropping are somewhat similar to those of some of the older countries in Europe, and therefore the methods of wheat cultivation are similar, except that in the United States more modern machinery is usually employed In these districts farming in general is becoming rapidly more intensive, and heretofore much more attention has been paid to crop rotation and thorough cultivation than on the large wheat farms in the West In rotations with wheat, clover, timothy, and other forage crops are commonly grown, as well as corn, and much use is made of manures, including both common stable manure and artificial fertilizers The use of artificial fertilizers is especially common in the eastern and southern States, South Carolina probably making the largest use of such fertilizers in proportion to its area of all the States. The usual fertilizers applied are those commonly known to be required for wheat, not only in this country but in Europe, including chiefly potash, some form of phosphate, and nitrogen in combination

In these districts wheat is sown in the fall, and may follow corn, cotton, or some green manure crop turned under, or may be planted in ground that has rested over the summer or that has been summer-tilled While the practice is still too common in eastern and southern States to sow broadcast, there is even in these districts a considerable use of the drill, which is increasing every year. Where wheat follows corn it is often planted by running a one-horse drill between the corn rows There is no cultivation of the wheat after seeding in any part of the United States, though such operation is sometimes practised with other small grain crops, particularly rice In almost all localities the farmers have long ago gone beyond the use of the old-style implements, such as the sickle and cradle, in harvesting, though these may yet occasionally be seen. The most common machine for harvesting is the self-binder. After the grain is bound into sheaves by this machine it is then usually put in shocks, and often, though not always, stacked a few days later. It is now rather common in many places to thrash wheat direct from the shock After this method, however, it is known that the quality of the wheat is not so good as in cases where stacking is practised.

In the States of the Plains, and particularly in the western portions of these States, while there has been heretofore much carelessness in wheat cultivation, recently the farmers have learned from force of circumstances that they are obliged to use much better methods, because of the general lack of rainfall. There has developed, therefore, in recent years a system of so-called 'dry farming', which is applicable throughout a large portion of the most important wheat areas, that is, throughout the Great Plains generally and the inter-mountain and Pacific Coast districts The methods of cultivation under this system are really little different from those that *should* be employed in the eastern States, but, as stated, they have been brought to the attention of the farmer with greater emphasis because of the fact that they are requisite in conserving moisture. They are, therefore, not so necessary in the eastern States, where fairly good crops can be obtained without so much attention to the preparation of the soil. The principal feature of this method of farming is the production of a seedbed that will conserve all the moisture possible that falls The ploughing must be deep, and should be performed at least three to six weeks before the time of seeding Afterwards there is constant surface cultivation, chiefly harrowing, but sometimes a disk machine is employed when the ground becomes a little harder than usual This surface cultivation is usually done just after rains One more cultivation is given just before planting, and then the wheat is sown with a drill This is the method when wheat follows other crops Sometimes where the rainfall is extremely light it is common to practise summer fallowing, or, more correctly, summer tillage In that case there is no crop at all on the ground during the season preceding the sowing of the wheat crop, but the ground is cultivated throughout the summer in the manner just mentioned

Throughout the central and western districts there is so far almost no use of fertilizers, except that occasionally a farmer will put on the ground any surplus stable manure that he may have The ground is usually black clay loam and is, of course, very rich Nevertheless it is probable that fertilizers will some time be used

In these districts the methods of harvesting and thrashing are more up-to-date than in the eastern States, and are conducted on a much larger scale. While the self-binding harvester is commonly used, in some places 'headers' are employed which cut the wheat some distance above the ground. As the grain in these instances, however, is at once stacked, the header can be used only in the drier districts, and even then when the wheat is pretty well ripened In the inter-mountain districts and on the Pacific Coast a large combined harvester-thrasher is commonly used. This machine cuts 75 to 100 acres a day, and the grain is harvested, thrashed, and sacked at the same time It is still more important in the use of this machine to harvest at the latest date possible, that the grain may be thoroughly dry. For this reason millers have made some complaints of these operations, as the late date of harvesting allows a considerable deterioration in the gluten content of the grain. [M A. C.]

Wheat. — Parasitic Fungi. — Rust. This widespread and serious disease may appear

any time in summer as an orange-yellow powder on the lower leaves. As the rust proceeds upwards the leaves hang down and wither, and the plants lose vigour; when the chaffs become rusted, the grain is shrivelled and poor. Rust is caused by several species of *Puccinia* which differ in minute structural details. The life-history of *Puccinia graminis*, illustrated in art. Fungi, fig. 11, is typical: summer rust is due to the leaves being coated with uredospores, which propagate the disease from plant to plant, the dark-brown teleutospores appear about harvest, and serve as winter-spores. The sporidia produced from germinating teleutospores do not infect wheat, but on another host, the Barberry, they produce the æcidum-stage, the wheat being infected by the æcidospores. Many points regarding this and other wheat rusts are still obscure in spite of much investigation. How the fungus passes from one year's crop to the next is not yet clear. Numerous observations indicate that rust occurs where Barberry is absent, nor has it been proved that teleutospores can infect wheat. It is, however, possible that autumn-sown wheat is infected from uredospores in autumn. An important suggestion advanced by Eriksson is that an internal germ ('mycoplasm') invades the grain and passes into the seedling. Neither spraying nor seed-treatment has been successful with rust, and the only way is to select for cropping those varieties which have been observed in any locality to remain rust-free. Generally these rust-proof varieties are poor yielders, but recently experiments have been made to raise good-cropping rust proof varieties by hybridization, and results may be expected in this direction. See colour Frontispiece, vol. xi, and also succeeding section.

Ear Smuts, Stinking Smut or Bunt.—The grains become filled with a black mass of spores, and the grain-coat generally remains entire even after threshing. Bunted grains can be distinguished by their dirty-brown colour and swollen appearance, and on bruising them the enclosed black mass of spores gives off a strong smell like putrid herring. Flour containing bunt retains this smell and is discoloured. Bunted wheat is not liked by stock, and if mixed in large proportions with food may cause poisoning. The life-history of the fungus is described in arts. Tilletia and Fungi (fig. 10). Loose Smut (*Ustilago tritici*) is distinguished by the grain being destroyed in the field, so that only the blackened axis of the ear remains at harvest. See colour Frontispiece, vol. xi.

Treatment.—Smut and bunt spores adhere to seed-grain and infect seedlings, hence clean seed is necessary. Seed treatment is regularly carried out in some districts, the methods being those described in art. Barley—Parasitic Fungi. For bunt the copper-sulphate steep is 1 lb. in each 5 gal. water. Formalin (1 lb. in 40 to 50 gal. water) and hot water are also recommended. As the grain swells in steeping, allowance for this is necessary if seed-drills are used.

Powdery Mildew.—This occurs as greyish velvety patches of *Erysiphe* on the stem and lower leaves. It is generally most pronounced in a sunless season, and as the crop is usually tall when it appears, no treatment has successfully checked it. [W. G. S.]

Rust of Wheat in Australia.—There are special features in connection with the rust of wheat in Australia that are well worthy of being referred to in any account of this widespread disease. The amount of wheat grown in the Commonwealth is sufficiently large—being approximately 63,674,329 bus. in the season 1908-9—to make the investigation of this and other diseases of great economic importance, while the losses caused by it in seasons favourable to its development are very serious. Thus in the so-called rusty year of 1889 it was estimated on reliable data that there was a loss of between £2,000,000 and £3,000,000 sterling, and every year it is present in the wheat crop to a greater or less extent. Besides, the climate, generally speaking, is not unfavourable to the growth of parasitic fungi of this nature, for there are over 160 species of rusts recorded for the island continent, and one genus (Uromyceladium) is unique, inasmuch as it is the only one known in which the hypha-bearing teleutospores are branched near the apex.

Coming to the rusts which attack wheat, there are only two known here, viz. the Black Rust (*Puccinia graminis*, Pers.) and the Brown Rust (*P. tritacina*, Eriks.). Curiously enough, the Yellow Rust (*P. glumarum*, Eriks. and Henn.), which seems to be very prevalent and to cause considerable damage in Britain, does not occur in Australia; and if attention be confined to those rusts only which cause serious loss, then there is only one, *P. graminis*, for the other, *P. tritacina*, does not pinch and shrivel the grain like the former, and is therefore not regarded with much concern.

In dealing with *Puccinia graminis* or Black Rust in Australia, the problem is not exactly similar to that presented to the British farmer. In the first place, the seasons are so different that a corresponding change has been brought about in the life-history of the fungus. The wheat is generally sown in autumn or the beginning of winter, viz. April to June, and it is ready for harvesting towards the end of spring and early summer, viz. November and December. The consequence is that the spores of the rust do not undergo a period of rest during the winter, nor are they exposed to severe cold, but they lie dormant during the summer months; so that the 'wintering' of the spores is a misnomer, and is really a case of 'summering', or passing a period of rest under genial heat conditions, instead of being cold and freezing. The heat of summer, however, just as effectually renders them inactive as the cold of winter. The uredospores or summer spores are killed off by severe cold, as Eriksson found they lost their capacity for germination during the winter if exposed to the weather, but retained it to a certain extent if kept indoors. In the comparatively mild winters of Australia they retain their power of germination, and the writer has had uredospores from both species of rust germinating freely in water during the winter months (June to August). They can either germinate at once and directly

infect a wheat plant if it is available, or they can act as resting spores for a time, tiding over the summer, and ready to infect the next season's growth under the climatic conditions which prevail here. Since the so-called summer spore is capable of continuing the growth of the parasite from season to season, it is produced in great abundance, a badly rusted field rendering one's clothes quite red from the mass of spores deposited on them while passing through it.

This is one of the first special features to be noted in the life history of the rust of wheat in Australia, that the uredospores are able to tide over the period between harvest and next year's growth, and thus the parasite perpetuates itself.

The next important distinction is that the teleutospore or so-called winter spore has lost its function of using the Barberry as an intermediate host. Teleutospores are formed commonly enough, and are usually to be found on the stubble of a rusty crop, but while the uredospores are formed in immense numbers and in great abundance, the teleutospores are generally not so conspicuous. After a period of rest they are able to germinate, and it was noticed that this always occurred in the spring, from September to November. If the uredospores are able to perpetuate the fungus, the question may be asked, What is the use of the teleutospore? In Britain the sporidia from the teleutospores are believed to infect the Barberry, and from the spores thus produced to reach the wheat plant; but in Australia the teleutospore produces no effect upon the Barberry, nor upon the wheat plant itself, and it seems to be a stage in the life-history of the fungus which has become functionless and is gradually dwindling away. It is very noticeable in the northern areas of the Commonwealth that this stage is not at all conspicuous, so much so that many farmers have never observed it and are only familiar with Red Rust. It forms a striking instance of a reproductive stage of a fungus becoming unnecessary under changed conditions, and even within a limited period tending towards extinction.

At present there is only one way known whereby the rust fungus survives from year to year, and that is by means of the uredospores; for although it is said that the mycelium may remain in the seed and give rise to the fungus on the germination of the grain, or that an internal germ of disease may be inherited from the parent plant and remain latent in the seed, yet neither of these views has been scientifically proved. It only remains now to state the means which are being adopted to combat this disease, which is one of the most widely distributed and the most destructive to cereals. Hundreds of different varieties of wheat have been tried from Europe, Asia, Africa, and America, but none of them have been permanently successful in resisting the rust. The only promising means seem to lie in the production of wheats suited to Australian conditions by crossing, as has been done by the late Mr Farrer, and is now being done by Mr Sutton of New South Wales and Mr. Pye of Victoria. The parents are being tested as to their rust resistance or rust liability, combined with their yielding, milling, stooling, and other properties which recommend them to the farmer. As the result of such tests they are mated together, and selections made from such crosses. Now that it has been shown that inheritance of or immunity from disease obeys Mendelian laws, it is hoped that wheats suited to the different wheat-growing areas of this large continent may be secured which, while fulfilling the farmer's requirements, will be able to resist successfully the ravages of the Black Rust, *Puccinia graminis*. [D. M'A.]

Wheat, Products of.—The wheat plant has been cultivated from the very earliest times for the grain that it produces. This has formed one of the staple foods of mankind from the very dawn of agriculture, and indeed in some parts of the world the terms 'agriculture' and 'production of wheat' are still almost synonymous. The world's produce of wheat grain is almost entirely utilized for the manufacture of flour (see Flour), in the course of which process various by-products ('offals') are obtained which constitute some of the most important feedingstuffs used upon the farm (See Bran, Sharps, Flour.) The straw of the wheat crop is chiefly valued as litter.

Wheat Grain.—The grain of wheat, being free from husk, is generally richer in albuminoids and carbohydrates, and also rather more easily digested, than barley or oats. Its composition fluctuates considerably according to variety, soil, climate, and other factors, but is commonly much as follows:—

	per cent
Moisture	13·0
Albuminoids	12·5
Oil	1·7
Crude fibre	2·5
Ash	1·8
Soluble carbohydrates, &c. (by difference)	68·5

The *albuminoids* of wheat are collectively referred to as 'gluten', and play an important part in determining the baking quality of the flour obtained from the grain (see Flour). They appear to consist mainly of the two albuminoids glutenin and gliadin, but others are also present in small proportions. Wheats grown in continental climates are generally richer in albuminoids than those grown under the more equable and moist climatic conditions of this country; and this fact has commonly been regarded as the explanation of the superior baking qualities of the flours prepared from the former class of grain. Recent investigations indicate, however, that the difference is probably the resultant of a variety of factors, and is not so simply explicable (see Flour).

The *carbohydrates* of wheat consist almost entirely of starch, this being accompanied by small amounts of pentosans, dextrins, and sugars.

The *ash* of wheat grain, like that of the other cereals, is notably rich in phosphoric acid (45 to 55 per cent) and potash (30 to 35 per cent). It contains usually 10 to 15 per cent of magnesia, but only 2 to 4 per cent of lime.

In general it is only inferior, unmarketable wheat ('tail corn', sprouted, smutted or otherwise damaged grain) that is retained upon the

farm for feeding purposes Such grain is usually a little richer in albuminoids and fibre, and poorer in carbohydrates, than the saleable sound grain.

Wheat grain is a useful food for all classes of farm animals, but requires to be used with caution since it is liable to cause digestive disturbances. The risk is greatest with newly-harvested grain, or grain that is affected by bunt, smut, or similar fungoid attacks Such damaged corn can indeed only be used with safety after subjecting to a thorough steaming or boiling with water

Wheat appears to be more efficient for the production of body substance than of muscular energy, and is hence best suited for fattening animals Wheat is a highly valued food for poultry, but if used exclusively or too freely may cause a falling-off in egg production, the females becoming broody and going off in condition

Wheat Straw is chiefly used as litter, for which purpose it is superior to other cereal straws (see Litter) For feeding purposes it is commonly regarded as the least valuable of straws, being hard in texture and very rich in crude fibre Like all straws it varies greatly in composition according to soil, time of cutting, &c (see Straw), but the data given below may serve as a rough guide

	per cent
Moisture	14
Albuminoids	3
Ether extract	1½
Crude fibre	37
Ash	4½
Soluble carbohydrates, &c (by difference)	40

The albuminoids are only slightly digestible, whilst the carbohydrates and fibre are commonly digested by cattle to the extent of about 40 to 50 per cent If used as food, wheat straw should only be given to cattle and sheep, and to them only in moderate amounts [e c]

Wheat, Statistics of.—Wheat, as the breadcorn of so large a section of the Caucasian race, has attracted more statistical enquiry than any other agricultural product Only the merest summary of the available figures of the area, production, trade movements, and prices of this cereal can find a place here The student in search of details must consult the numerous official returns and technical publications. In one or other of both hemispheres of the world wheat now occupies well over 240,000,000 ac ; and the crop of a single year, grown under the most diverse climatic conditions and under very different systems of farming, supplies an aggregate of more than 430,000,000 qr , of which quite a sixth part is produced for consumption in other countries than those where the grain is reaped.

Three great States—the Russian Empire, the United States of America, and the various sections of the British Empire—account for well-nigh two-thirds of the world's wheat lands. India furnishes the largest surface of the British quota But there, and in Australia, the yield falls below 12 bus. to the acre in the one case and below 10 in the other, while similarly small yields are common in Russia and in Argentina, both countries whence large exports are nevertheless drawn Even in the United States, as a whole, 13½ bus on an acreage of 47,000,000 ac. have hardly been reached on the average of the last five years In Canada, where recent large extensions in the North-west have carried the total acreage beyond 9,000,000 ac , much better rates of production are reported. With these results, however, 32 bus. per acre of the United Kingdom compare favourably, while the three small European States where the wheat yield slightly exceeds our own have only insignificant areas, even when compared to the 1,857,000 ac which the most recent statistics show are still grown in this country

Even within our own islands the local yield of wheat varies considerably A ten years' average of only 22 or 23 bus is found in parts of Wales, while on the small areas of some Scottish counties 40 bus is exceeded, and even 46 bus reached in Midlothian, and the restriction of wheat areas in Great Britain tends to raise the level of the annual production. This reduction of the surface under wheat at home, which has brought our acreage of over 3,000,000 ac in 1880 down to well under 2,000,000 ac , has been the prominent feature of recent agricultural changes, and must be ascribed to the lowered prices brought about by the development of new wheat lands abroad and the remarkable reduction in the cost of transport An average level of above 50s per qr was maintained over long periods up to 1874 Up to 1884 a ten years' average still gave 45s , while the next decennial period averaged little over 30s , and a minimum of 22s 10d per qr was reached in 1894 Indeed as much as 30s was only twice recorded up to 1907 Since then higher values have ruled, and 36s 11d was reached in 1909, followed by a recovery in the acreage sown from the lowest level of 1,400,000 ac reported in 1904

Only twice in recent years has the home production reached or exceeded 64,000,000 bus , and our population of 45,000,000 now derives nearly four-fifths of its breadcorn from oversea sources The home crop of 1909 has been put at 23 per cent of the whole, while another 31 per cent came from British Possessions, and 46 per cent from foreign States The sources of supply have, however, varied greatly. In 1881–90 the United States were furnishing one-half of our annual imports, while another fourth was provided by Russia and India collectively. Within the present century the quota of the United States has declined both absolutely and relatively Russia and India, with wide annual fluctuations, send rather more than twenty years ago, while the relative growth in our imports must be credited to the newer class of exporters, Argentina and Canada — the former sending us, over the last three years, an annual average of 27,000,000 cwt , and the latter of little under 18,000,000 cwt. Recent enquiries indicate no room for apprehension that the areas now or soon to be available for the growth of wheat will not amply suffice for the wheat-eating populations of the world. [r. g. c.]

Whey.—By curdling milk with rennet, it is split up into curd and whey, the constituent of

the milk on which the rennet acts is the casein, from which is formed the insoluble curd and a soluble whey protein. The curd carries down the greater part of the fat globules, and carefully prepared whey contains but small quantities of fat.

Practically whey, a semi-opaque yellowish liquid, is always the by-product of cheesemaking. When quite fresh it is always less acid to phenolphthalein than the milk from which it was prepared; but as the milk is always warmed to a temperature favourable to the action of rennet, at which temperature micro-organisms are also active, the development of lactic acid proceeds with fair rapidity, and when the whey is drawn the acidity is about the same as that of the milk, and it gradually increases on standing.

The average composition of whey is —

Water	93 26
Fat	0 25
Milk sugar	5 00
Proteins	0 92
Mineral matter	0 57

The calcium and phosphates of the milk are largely removed in the curd, and only about one-third of the total of these constituents appear in the whey; practically the whole of the other mineral constituents are, however, present, together with those (chiefly sodium chloride) added with the rennet.

The whey protein split off by the action of rennet from the casein contains a much smaller percentage of nitrogen than the proteins of milk, this being only 13·25 per cent, according to Hammersten, as against 15·7 per cent for the milk proteins. Estimations of the proteins in whey by multiplying the nitrogen by the usual factor give results below the truth from this cause. The whole of the albumin present in the milk is contained in the whey.

On acidifying whey a very fine precipitate is formed, and on boiling the acidified whey a considerable amount of coagulated albumin is thrown down. Sweet whey on heating yields a 'skin' like that formed on heated milk, and a soft precipitate of albumin is formed.

The chief uses of whey lie in the feeding of pigs, and in the manufacture of milk sugar. It is readily seen from the composition that if the fat or proteins are removed a solution containing but little except milk sugar and some mineral matter is obtained, and on boiling this down, the comparatively insoluble sugar crystallizes out.

Whey is also given as a diet for invalids, especially in diseases of the lungs, and in chlorosis or anæmia. It is probably of use in these diseases partly because it is very easily digested, partly because it has a slight diuretic effect, but principally because it contains all the enzymes and vital constituents of the milk together with much of those added in the rennet. It is also used as a food for children, seldom alone, but generally mixed with cream for very young infants, and milk, cream, and sugar as they grow older; for infant feeding its employment is more as a diluent for curd than for its special properties. [H. D. R.]

Whin, Gorse, or **Furze** (*Ulex europæus*). —Gorse (nat. ord. Leguminosæ) occurs naturally on poor mountain stony land, and if allowed, soon establishes itself on thin, dry, or heathy soils. In most parts of the country, gorse is regarded as entirely undesirable, and even where it occurs abundantly in waste places no attempt is made to utilize it as food.

In a few parts of the country, however, notably in some parts of Wales, for instance in South Carnarvonshire, Merionethshire, Pembrokeshire, and the hill districts of Carmarthenshire, and in some localities in Ireland, not only is advantage taken of the gorse growing naturally on the adjoining mountain slopes, but in many cases it is cultivated and regarded as a valuable and almost indispensable crop.

Cultivation of Gorse.— Though occasionally found on the better classes of land, gorse is more commonly grown and is more permanent on poor soils, where it suffers less from the competition of grass and other weeds, which, after a few years, weaken it and cause it to become patchy on fairly good land. In any case the soil must be naturally well drained, a wet clay subsoil being very injurious to the crop. Mention may be made of the common practice in the coal districts of South Wales of sowing the older and slightly weathered spoil heaps with gorse, generally without any manurial treatment beyond a topdressing of compost after the crop is established. When sown on good agricultural soils the gorse is seeded down like grass, along with a corn crop, usually oats, at the rate of 25 to 35 lb. per acre. The plants come up very thickly, and do not assume the bushy and woody character usually seen when growing wild. The first cutting is generally taken two years after the corn has been harvested, but may be made a year earlier. The crop is afterwards usually cut every two years, so that a common practice is to have two pieces of gorseland, which are reaped alternately. Sometimes the crop is cut every year, but this weakens the plants and they often soon die out. On good land, after about ten or twelve years the gorse suffers from the competition of grass and other weeds and becomes patchy. In such cases it is ploughed up, the land is put through a course of cropping and seeded down again, exactly as grass would be treated in the same districts, though when breaking the land up, some of the stronger roots may have to be dug out by hand. On poorer mountain soils the crop is more permanent, and is seldom broken up.

Gorse as Food. — The crop is usually cut with a hook or slasher, though when reaped every year a scythe is sufficient. Cuttings generally begin about November and continue through the winter. It is not advisable to cut more than a two days' supply at once, as gorse readily ferments and deteriorates on keeping. It is used in various ways, *e.g.* in some districts as a substitute for hay or straw, and is fed mixed with roots, in others it takes the place of roots and is mixed with hay. Methods of preparation also vary in different districts: in some it is simply chaffed with a strong ordi-

nary chaff-cutter; though more commonly a much stronger type of chaffer is used, having knives set tangentially in a drum slightly similar to those of an ordinary turnip cutter. In many districts the gorse is not only chaffed, but is also bruised in a special machine. When to be fed along with hay chaff, the two are often mixed and allowed to ferment together for about twelve hours before using, but in any case the gorse should not be chaffed or bruised long before it is required, as it loses its aroma and becomes less palatable.

Gorse is only fed to adult stock, principally horses and dairy cows, which, when accustomed to it, become very fond of it, and clean up readily even most of the woody parts. There can be no doubt that stock do well on it, and the popular estimate of its value is that it is quite equal to hay, some farmers even prefer it to hay, particularly for milking cows. The quantity fed per animal varies very much, but at least one feed a day of it is given, and from about 10 to 25 lb daily would represent average limits.

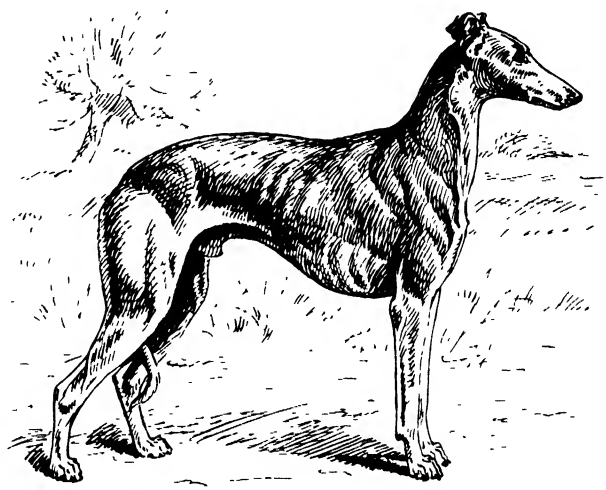
When a tenant leaves his farm the gorse is valued like other crops, the amount awarded being fixed by the regularity of the plant, the time it has been down, and whether ready for immediate cutting or not.

Without making extravagant claims for the crop, there can be no doubt that, at any rate in rough mountain districts, its cultivation could be very profitably extended, particularly where it is desired to keep a heavy stock through winter.

[R. G. W.]

Whinstone, a popular term for the dark crystalline igneous rocks that crop out as dykes or rugged surfaces among other more tractable materials. Their resistance to weathering, and their appearance in consequence as knobs and bosses above the general level of the country, causes them to be given over to 'whins' (furze) or heather. Very often, however, they furnish the best of road-metals (see art. Basalt), especially when they are of the dolerite type, that is, intermediate in grain between diorite and basalt. [G. A. J. C.]

Whippet.— In many parts of the country the Whippet, or Snap dog as he is sometimes called, is the most highly prized of all the varieties of dogs. The reason of this is, that he is utilized for the sport of dog-racing, which possesses a strong hold upon the feelings of many people in the northern mining districts. In general appearance the Whippet exactly resembles a greyhound, but the former is, as a rule, a very much smaller dog; though the division line that exists between a heavy-weight Whippet and a light-weight greyhound is practically non-existent, as will be seen when it is mentioned that Coomassie, who twice won the Waterloo Cup, scaled 44 lb., whilst Ploughboy, a famous Whippet, weighed 42 lb. when in training. The supporters of dog-racing, however, have got over the difficulty resulting from the difference in weights by adopting the handicap principle, under which the bigger dogs, as well as those which have proved themselves to be speedy on previous occasions, are made to give the others starts. The Whippet is rather a delicate dog, this being doubtless a result of the coddling the most valuable specimens have received whilst in training; and as these of course



Whippet

have been bred from their descendants have as a matter of course become less robust in constitution. [V. S.]

Whistling, a nervous affection of horses. See Roaring and Whistling.

White Clover. See Clovers.

White Crops, a provincialism for cereal crops. See Oats, Barley, Rye, and Wheat.

White Currants.— These are merely colour varieties of the Red Currant, and the same treatment suits them. Transparent White is a good variety. See Red Currants.

White English Terrier.— It is a regrettable fact that this very beautiful variety of dog has become practically extinct, and as the tastes of the admirers of fancy dogs nowadays appear to run entirely in the direction of foreign breeds, there does not seem to be any prospect of the White English Terrier being resuscitated. At the same time it must be admitted that the variety served no particularly useful purpose, as it was not conspicuous for its courage or resolution in attacking vermin, and many specimens were inclined to be snappish in their tempers, which reduced their value as companionable dogs. It is a rather curious fact too that quite a fair percentage of the best-looking White English Terriers of the past were more or less

afflicted by deafness, which was attributed by some people to the results of cropping their ears and by others to their white colour. The latter reasoning will, however, find few adherents, though it is a strange coincidence that show Bull Terriers, which are also white, are often hard of hearing, if not absolutely deaf. As regards the shape and make of the White English Terrier, it may be observed that he is an exact replica of the Black-and-Tan Terrier, the description of which may be referred to for information on the subject. [J. S.]

White Mustard. See MUSTARD CROP.

White Scottish Terrier.—Although the white colour occasionally occurs in the hard-haired Scottish Terrier, of late years a great deal of support has been accorded to the Rosneath or West of Scotland variety, which undoubtedly is very closely allied to the first-mentioned breed. The difference in colour is in fact the main distinction that exists between them, the points of dissimilarity in shape and size being practically non-existent. As may be supposed, the West of Scotland breed is a valuable vermin dog, being possessed of courage, a fine hunting capacity, and the iron constitution which is so characteristic of all the varieties of Scottish working terriers. It may be suggested also that the white colour is an advantage to a dog that is called upon to do its work underground, as it renders the animal easily distinguishable from surrounding objects, which in the case of terriers which are hunting badgers or foxes is a great point to be considered. As in the case of the hard-haired Scottish Terrier, the possession of a really harsh weather resisting jacket is a point in connection with this breed the importance of which cannot be exaggerated, and hence it is a great mistake on the part of those who breed these dogs to coddle or pamper them in any way. If this is done the texture of the coat is certain to become softer and the constitution weakened, whilst if they are degraded to the level of household pets these terriers are apt to lose their capacity for work, and to acquire a disposition to fraternize with strangers which is wholly opposed to their nature, the Scottish Terrier being essentially opposed to anything of the kind. [J. S.]

White Scour, a persistent evacuation of almost colourless and fluid fæces, differing from ordinary diarrhœa in its origin and continuance as well as consistence and odour, and leading to wasting anæmia and death, and often complicated by swelling and inflammation of the joints. The losses among dairy farmers in Ireland from this cause had become so serious at the end of the last century, that the Government of the day called in the services of Professor Nocard to investigate the malady. He established the fact that white scour in calves was due to a specific infectious organism, and further demonstrated by experiment that joint ill in young creatures is due to the same maleficent pasteurella. These disease germs gain access to the body through the open navel string or umbilical cord, which only becomes resistant when dried off in the usual way. The danger period is from the moment of birth until this has taken place. The organism lives in the litter, and infects buildings and, to a lesser extent, the land upon which calves have been reared. In some cases the calf no sooner recovers from the scour than he is attacked in the joints, and in others a cough supervenes, and inflammation of a low eruptive character ending in consolidation or so-called hepatization of the lungs, and death of the emaciated animal. This malady should be distinguished from diarrhœa or scouring from indigestion and unsuitable food, overdriving and fright, exposure and long fasting on shipboard and in railway trucks, but the same class of astringent remedies may be employed (see SCOUR). Some benefit appears to be derived from the administration of dram doses of permanganate of potash in the first instance, or 10 to 20 drops of carbolic acid in milk, but the chief concern of the breeder should be to prevent the disease. Directly the animal is born, the navel and the skin immediately adjacent should be anointed with carbolized oil, and the umbilical cord tightly tied about 2 in. or less from the belly. The cord itself should have an application that is at once an antiseptic or germ preventer, and a drier, to encourage the process of withering of the tissues. A very effectual application is that of salicylate collodion. Solutions of perchloride of mercury in methylated spirit (1 in 1000) also have the desired effect. If pure carbolic acid is used, care must be taken to touch only the navel string itself, and avoid splashing the skin. It is important to keep the floors and bedding clean, and to disinfect all places where infected animals have been kept. [H. L.]

Whitethroat (*Sylvia cinerea*). This small Warbler is widely distributed through Britain from April to September, frequenting hedges and bushes. The upper part of the head and body are grey, the wings brown, and the under parts white, with white outer feathers to the tail. The nest is built in early May, and is situated not far from the ground in a bush. The five eggs are very variable in colour, but commonly greenish with pale brown spots. Although the food partly consists of insects, on which the young are fed, this species, like its near relative the Blackcap, is fond of various kinds of fruit, and the fruit grower is justified in keeping down its numbers. [J. R. A.]

Whitewash, or **Limewash,** is the name given to a preparation of quicklime and water which is largely used as a dressing for the walls of houses in order to preserve them from the disintegrating action of the weather, as well as to keep up a good appearance. The quicklime is mixed with sufficient water to give a liquid of a thick, creamy consistency, which will adhere readily to the walls when applied. If too little lime be used, the wash has a tendency to run and does not give a good cover, while if too much, too thick a layer is formed on the walls, and it readily falls off under the action of heat, frost, &c. Farm buildings should be whitewashed once every year, preferably in late spring or early summer, so that they may be looking their best during the summer months. Besides, if delayed till autumn, frost may split off the layer of lime before it has become firmly set.

The wash must always be used in a fresh condition, otherwise its covering powers will be much diminished In some cases a certain amount of 'copperas' or sulphate of iron is added, and this gives to the walls a brownish-yellow coloration, which is preferred by some people. The other important use of whitewash is as a disinfecting agent in stables, byres, loose boxes, cattle sheds, auction marts, &c ; and in this case also it must be prepared afresh on each occasion. The interior of all farm buildings should be thoroughly whitewashed twice a year, in spring and in autumn, and in auction marts much oftener is required. In cases where infectious diseases have occurred, it is advisable to add to the wash a small proportion of carbolic acid, Condy's fluid, bleaching powder, paraffin, or other disinfectant, in order to increase its cleansing properties, as it has been found that ordinary limewash will not destroy any bacterial spores which may be present The whitewash may either be applied by means of hand brushes, or by a special limewashing machine. The latter is specially useful where the main object is to disinfect the premises, and where the work requires to be done frequently, as in auction marts See art LIMEWASHING MACHINE

[J W]

Whitsunday, the first of the Scotch legal term days, is, strictly speaking, the fiftieth day after Easter, but, in Scotland, is always held on the 15th day of May, if a lawful day for business See under QUARTER DAYS, REMOVAL TERMS.

[D R]

Whortleberry. See art BILBERRY

Wicklow Sheep.— The light class of active hill sheep which are kept on most of the up-lying farms in Co Wicklow have come to be referred to in the Dublin market and in the neighbouring counties as Wicklow or Wicklow Mountain sheep Apart from their suitability to the character of the grazing and the exposed situation of the holdings on which they are produced, as well as the handy carcass weights they provide for the butcher when fattened off, there is no distinctive breed characteristic they can be said to possess Whatever the foundation stock may have been —and these were likely a small hardy type of mountain ewes the Wicklow sheep, as now met with, shows a strong predominance of Cheviot breeding To a slight extent evidences of Border Leicester crossing may also be noticeable, but it has been mainly through the introduction of Cheviot blood that the present Wicklow Mountain sheep has been produced Improvement in quality and conformation has been attained through the use of Cheviot rams; so much so that there are many points of resemblance between the best specimens of the Wicklow sheep and the breed to which they are so closely related. As a rule, however, the real Cheviot is smaller in the body, shorter in the leg, and finer in the bone, carries better sprung ribs with shorter and closer wool, and is if anything hardier and more active than the resultant cross, on the other hand, the Wicklow sheep are better sucklers, and partly for this reason, and partly on account of their greater size and scope, are better adapted for the production of market lambs, for which purpose they are principally bred The quality of Wicklow mutton is excellent, and finds much favour both with butchers and consumers the former prefer sheep of a light carcass weight which at the same time throw a small percentage of offal and furnish convenient-sized joints, the taste of the latter in mutton tends more towards evenness and flavour of the fleshing, hence it is not surprising to find that the Wicklow wedder mutton secures the highest weekly quotation in the Dublin market

The largest sales of Wicklow Mountain sheep take place in the autumn months at the fairs of Rathsallagh, Baltinglass, Roundwood, Tinahely, and Blessington. The ewes are largely bought by lowland graziers in the neighbouring counties, who cross them profitably with Shrop, Border Leicester, Lincoln, and Oxford Down rams All these crosses do remarkably well, but it is the general view that best results are obtained from the use of the Border Leicester ram Such Wicklow ewes may be bought, according to quality, at prices which range from 24*s* to 35*s* During July and August a large number of wedders are bought at Co. Wicklow fairs by graziers from other counties at rates ranging from 27*s* to 35*s* These are usually kept over winter on rich sheltered lands, and with a little hand feeding are disposed of in February when they fetch from 50*s* to 55*s* if sufficiently finished for the butcher. The usual profit expected by graziers for wintering is £1 per head

Of late years considerable improvement has been made in the quality of Wicklow sheep, and with a constant home demand for finished mutton as well as an annual demand for breeding ewes and store wedders, the prospects of the Wicklow Mountain sheep appear unusually bright

[O W H R]

Wild Ass. See ASS, KIANG

Wild Birds Protection Acts. These Acts, so far as now in force, are the Act of 1880 (43 & 44 Vic c 35) and the amending Acts of 1881 (44 & 45 Vic c 51), 1894 (57 & 58 Vic c 24), 1902 (2 Ed VII, c 6), and 1904 (4 Ed VII, c 4)

Under section 3 of the Act of 1880 a close time is provided for all wild birds from 1st March to 1st August Any person who destroys or takes, or attempts to destroy or take, wild birds between those dates, or who, after 15th March, exposes for sale or is in possession of birds recently taken, may be summarily prosecuted before the Sheriff, who may impose a penalty of £1 for each bird and costs, in the event of the bird being any of the following, namely: American quail, auk, avocet, bee-eater, bittern, bonxie, colin, Cornish chough, coulterneb, cuckoo, curlew, diver, dotterel, dunbird, dunlin, eider duck, fern owl, fulmar gannet, goatsucker, godwit, goldfinch, grebe, greenshank, guillemot, gull (except black-backed gull), hoopoe, kingfisher, kittiwake, lapwing, loon, mallard, marrot, merganser, murre, night-hawk, nightingale, night-jar, oriole, owl, ox bird, oyster-catcher, peewit, petrel, phalarope, plover, plover's page, pochard, puffin, purre, razorbill, redshank, reeve or ruff, roller, sanderling, sandpiper, scout, sealark, seamew, sea-parrot, sea-swallow, shear-

water, sheldrake, shoveller, skua, smew, snipe, solan goose, spoonbill, stint, stone curlew, stonehatch, summer snipe, tarrock, teal, tern, thicknee, tystey, whaup, whimbrel, widgeon, wild duck, willock, woodcock, woodpecker (sect. 3, and Schedule to the 1880 Act), and also larks (sect. 2, Act 1881) and any other bird the Secretary of State may declare to be included in the Schedule of the Act 1880, with respect to any district, on the application of the County Council for that district (sect 3, Act 1894) The penalty for all other birds is a reprimand and costs for the first offence, and 5s a bird and costs thereafter (sect 3, Act 1880)

The close time may be extended for any district, or the taking of eggs of any specified species, or of any species whatever, may be prohibited by the Secretary for Scotland on the application of any County Council An Order by the Secretary for Scotland must be advertised in the local newspapers and by fixing notices in public places

Liability may be escaped for exposing a bird for sale after 15th March by proving that the killing of the bird was lawful at the time when it was killed, or that it was killed in a place to which the restriction does not apply

An offender may be required by any person to give his name and address, and if he refuses, or gives a false name or address, he may be subjected in an additional penalty of 10*s*

Under the Act of 1902, where any person is convicted of an offence, the Court may not only impose penalties, but may also order any wild bird, or wild bird's egg, in respect of which the offence was committed, to be forfeited, or disposed of as they may think fit

Under the Act of 1904, any person who on any tree, pole, or cairn of stones or earth, shall affix, place, or set any spring trap, gin, or other similar instrument calculated to cause bodily injury to any wild bird coming in contact therewith, and every person who knowingly permits, suffers, or causes any such trap, &c, to be so affixed, &c, may be liable on summary conviction to a penalty not exceeding 10*s*, and for a second offence, not exceeding £5 [J C]

Wild Carrot (*Daucus Carota*) is a biennial weed belonging to the nat ord Umbelliferæ It is common on dry calcareous soils, on arable and on grass land, on roadsides, on grassy banks, and on seashores. This is the parent of our cultivated carrot; and although its root is quite hard, three or four generations of careful cultivation suffice to make it tender and eatable, as Vilmorin has shown Flowering occurs from June to August When in fruit the plant is easily recognized by the hollow umbel, subtended by divided bracts (*pinnatifid involucre*).

Sheep readily browse Wild Carrot, accordingly, in pastures where the weed is troublesome, the sheep should be put on to keep it down To prevent spread, the plants should be spudded or cut before flowering

[A. N M'A]

Wild Ducks. See Mallard, Duck

Wild Goose. — Geese are combined with the Swans, Ducks, and Mergansers to form the family Anatidæ. The wild geese that frequent the British Isles are divided by fowlers into 'Grey' geese and 'Black' geese. The Grey Geese comprise four species (1) The Grey-lag Goose (*Anser cinereus*), which is considered to be the principal source from which domestic geese sprung The Grey-lag Goose used to nest regularly in the fen district, but, like so many other birds, was driven out by the drainage of that country, and now breeds only in the north of Scotland, in the rest of Great Britain it is a rare bird (2) The White-fronted Goose (*Anser albifrons*) is a winter visitor only It is met with most frequently in the south and south-west of England, while in Ireland it is the commonest of all the Grey Geese (3) The Bean Goose (*Anser segetum*), and (4) the Pink-footed Goose (*Anser brachyrhynchus*), are both fairly common cold-weather visitors to our coasts, the latter species being particularly abundant on the East coast The Black Geese comprise the two species called the Bernacle Goose (*Bernicla leucopsis*) and the Brent Goose (*Bernicla brenta*) The Bernacle Goose is a winter visitor, more common on the West than on the East coast The Brent Goose is the most abundant of all the geese that visit this country, though like its congeners it only comes for the colder months of the year

The chasing of wild geese, although proverbially difficult, is carried on both with shoulder-gun and punt-gun In the case of the Brent Goose, which rarely wanders inland, the punt gun offers the easiest method of approach. Punt-gunning for Grey Geese is often pursued at night, shots being fired at random into the midst of the birds, which are collected the following morning, but the method is cruel and unsportsmanlike. With the shoulder-gun, Grey Geese may be waylaid on their flights to and from the feeding grounds, but driving is generally the most successful method If driving be adopted, it should be remembered that the birds on rising always fly against the wind [H S R E]

Wild White Cattle. — The wild white cattle of Great Britain at the beginning of the 20th century were represented by four wild remnants of some thirty herds mentioned historically by Storer in The Wild White Cattle of Great Britain (1879) These remnants are severally preserved at (1) Chillingham Park, Northumberland, where about seventy animals live absolutely in a state of nature, (2) Cadzow Park, Hamilton, where the herd numbers over sixty, and where, to restore decreasing vigour from intense inbreeding, bulls from Chillingham, Vaynol, and Lamphey have been beneficially used— the time of breeding also being controlled, as it is likewise in the remaining two herds, (3) Vaynol Park, North Wales, where the remnant (numbering about forty) of another Scotch herd originally from Blair-Atholl, but fortified by the introduction of West Highland blood—was taken in 1872 by G. W. Duff Ashton-Smith, and (4) Chartley Park, Staffordshire, where, till 1905 (when the establishment was sold to Colonel Congreve), the finest herd in point of size and weight had existed, in the possession of the Lord Ferrers, for over six and a half centuries A bull and a cow, excellent specimens, were left at Chartley. Only three of

the remainder, which met with an accident by fire on the railway, along with a Chartley-Vaynol bull from the London Zoological Gardens, were successfully transferred by the Duke of Bedford to Woburn Park, where, as at Chartley, efforts are being made to regenerate the herd. From forty-three in 1895 it had been reduced almost to extinction by an outbreak of miliary tuberculosis. Of the successful crosses at Woburn with cattle of the Jersey, White South Wales, and Longhorn breeds, the last is most successful—not only the characteristic colour markings, but the long sweeping horns and massive substance being best retained. At Chartley the White South Wales crosses are on the whole satisfactory. Storer, describing the wild cattle, says 'The universal colour was generally pure white, approximating in a few instances to cream colour, but with certain points otherwise coloured, and these points generally black. The tips of the horns, the muzzle' [also the tongue], 'the circle round the eyes, the hoofs, were in all the herds black, in some the brush of the tail was of the same colour, while the ears in all were either black or brown-red inside, and wholly or partially of the same colour outside. Black markings—particularly on the front part of the fetlock of the fore legs—and black or blush spots on the neck and at times on the body were general.' Any off-coloured calves, mostly black or sable, were killed. One exception to the general colour existed till 1806 at Leigh Court in Somerset (where a herd on becoming dangerous had to be put down) that was 'fawn tending to yellow, very red towards the flanks.' Red ear-markings now only linger in the Chillingham herd. A thin light skin is a characteristic of the breed, and so is the tendency to slow maturity, but the beef is excellent. The beauty of symmetry while at rest and the perfect action of conspicuous specimens of both the Chartley and Hamilton herds were specially remarked by the late John Thornton, the great salesman of Shorthorn and Jersey cattle.

Professors Boyd Dawkins and M'Kenny Hughes revived the theory that all the herds originated in cattle that must have broken away from civilization, because, no evidence of their existence having been found, it is argued that the early wild prototype in this country became extinct before the termination of the Bronze Age. Darwin, Low, and Storer held that the progenitors of the wild park cattle were directly descended from the *Bos urus* or *primigenus*, which lingered chiefly in the forests of the north of England and of Scotland, and was saved from extinction by enclosure in great parks soon after 1225, when the area protected by the forest laws was much reduced. The chief arguments on both sides and the recent history of the breeds are fully stated in Wallace's Farm Live Stock of Great Britain (1907). Intense in-and-in breeding was the chief influence at work in exterminating the herds and reducing the size of the animals left. The generally accepted belief that the survival of the remaining herds is due to the unrecorded timely introduction of outside blood, is strongly supported by the success which has attended the intentional importation of new blood into all but the Chillingham herd. The change of the Hamilton herd from a polled to a horned condition supports the tradition of the introduction of a West Highland bull. Five of the originally enclosed white herds were hornless. One of these—at Somerford Park, Cheshire—with black ears and points, including teats, still exists as a domesticated dairy herd.[1] After it had been depleted (as was also the Hamilton herd) by rinderpest, a Shorthorn bull was used in place of an inferior bull left in the herd. Cattle bearing the colour of the wild breed sometimes occur in the black Welsh breed, and a white herd with black points which breeds true to type has been collected by Charles Mathias, Lamphey Court, South Wales. White cattle with faint black or brown ear-markings very frequently occur as the progeny of 'blue-grey' cows, *i.e.* first crosses between Galloway or Aberdeen Angus and a white Shorthorn.

Further evidences of the relationship of our domesticated cattle to the wild park cattle and concurrently of the superior quality of the latter, are the success at Smithfield in 1888 and 1889 of first cross Chillingham Shorthorns, and the entry in Coates's Herd Book of Shorthorns produced from Chillingham cows by five crosses with pedigree Shorthorn bulls.

The cattle in all the pure herds, when bred in the open, exhibit the instincts of wild animals, hide their newly born calves, refuse to be driven, escape to a safe distance, and either keep on the move or get behind some object at sight of a stranger, but become decidedly dangerous if cornered and not allowed to escape. Especially so is the solitary old bull who, after a terrific sylvan encounter with a younger and more powerful rival for the supremacy of the herd, has been overthrown and made an outcast.

In winter, when all are fed on hay, and in recent years also a few pounds of cake daily, the keeper in charge, under shelter of a horse and cart, can approach very close to a herd while it is feeding.

Since 1890 there have always been maintained at the Zoological Society's Gardens in London a bull and cow of the white breed. All have bred freely and have been 'wonderfully tame, licking or feeding from the hand (through the bars), or allowing anyone to pat or stroke them without exhibiting fear or anger.' The bull in captivity has not been so troublesome as many old bulls of domestic breeds under similar circumstances, but the keeper does not enter the cow's loose box without holding a fork or some other means of defence in his hand.

In 1908 Sir Claud Alexander, Bart., Faygate Wood, Sussex, began to collect a herd of white wild and white polled cattle, also black specimens of them, from all available sources, and it is possible interesting results may follow the blending of many varieties. [R. W.]

Willow (Salix) is one of the two genera, the other being the Poplar (see Poplar), forming the Salicaceæ or Willow family of the natural order Amentaceæ or catkin-bearers. This family consists only of woody plants with alternate, simple, stipulate leaves; with inconspicuous, unisexual,

male and female flowers ranged in catkins on different individuals (not on same tree), and with ovaries changing into dry fruits, whose wall splits longitudinally downwards (usually along two lines) to expose their many cottony seeds, each having at its base a tuft of hairs making it easily wind borne. But the genus Willow differs from Poplar in consisting mostly of shrubs, as well as of trees; in the buds having apparently only 1 scale (but really 2 joined together); in the leaves being whole and unlobed, with short petioles, and in the male flowers having 2 to 12 (but mostly 2) stamens with long filiform filaments (whereas in Poplars there are 8 to 30 stamens with short filaments), and instead of the stamens and pistil being enclosed in a cuplike receptaculum, 2 glands are situated below the ovary (1 on each side). There are about 160 known species of Willow, nearly all of which are indigenous to the northern hemisphere, but there are also many hybrids, and in Europe alone there are 31 true species and at least 57 hybrids. Most of these are shrubs, and many of them are cultivated and coppiced to give withes for basketmaking (see OSIERS). Of the tree Willows only 2 true species are indigenous to Britain—(1) the Sallow Saugh, or Goat Willow (*S. caprea*), a very hardy, small deciduous tree or large shrub common in the highlands of Scotland, with broad oval and pointed leaves, generally twisted at the tip, smooth dark-green above, but covered with grey down beneath, and dark-grey or yellowish-brown bark with irregular longitudinal clefts and short cross-clefts, and (2) the Common White or Huntingdon Willow (*S. alba*), a large deciduous tree with light-brown bark and narrow elliptic-lanceolate leaves covered with silky hairs, whitish or greyish on the under surface, and the female flowers with 1 gland. But the Crack or Redwood Willow (*S. fragilis*), also a large deciduous tree with grey, deeply-fissured bark, ovate-lanceolate, very glabrous leaves, and female flowers with 2 glands—the branches and twigs of which are easily broken off at the point of junction with the stem (hence the specific name)—was introduced into Britain in the 15th century, and has so thoroughly acclimatized itself that a third species of large tree Willow, the Bedford or Russell Willow (*S. Russelliana*), has been formed as a hybrid of *S. alba* + *S. fragilis*, and is found in marshy woods, where it is easily distinguishable by its lanceolated tapering leaves, hairless and smooth on both sides, and larger than those of the White Willow. It is only these three large tree Willows—the White, Crack, and Bedford Willows—that are cultivated in our woodlands. They all yield a soft, even-grained, whitish, light-brown or reddish wood weighing only about 28 lb. per cubic foot, which is tough and durable if kept dry, and is much used for cart- and wagon-lining, packing cases, matches, pulp, &c. But the most valuable kind of Willow wood is that of the Cricket-bat Willow (*S. alba*, var. *cærulea*). The Crack Willow is the hardiest of the three tree Willows, and is therefore the kind chiefly grown in Scotland, while the White and Bedford Willows are the most common in England, and especially in the fen districts, where the White Willow is the best for coppicing and pollarding. They are all quick-growing, light-demanding trees, which can easily be propagated from slips of the last year's young wood. These tree-willows can attain a height of 60 to 70 ft., and a girth of 8 to 10 ft. on the deep, moist, loamy or sandy soil which suits them best. [J. S.]

Willow Aphis. See LACHNUS VIMINALIS and SIPHOCORYNE CAPREÆ.

Willow-herb (Epilobium) is the name applied to an extensive genus of dicotyledonous plants belonging to the nat. order Onagraceæ. The British species are perennial herbs either creeping underground or producing runners along the surface. The flower has four petals and eight stamens, which are inserted upon the apex of an inferior ovary so long and so narrow that it is apt to be mistaken for a flower stalk. When this inferior ovary is ripe, it splits lengthways into four valves, so that the wind may waft away the numerous hair-tipped seeds and disperse them hither and thither. Wet ground by streams and ditches is the favourite haunt of most Willow-herbs, such as Great Hairy Willow-herb (*Epilobium hirsutum*), Small-flowered Willow-herb (*Epilobium parviflorum*), and Square stalked Willow-herb (*Epilobium tetragonum*). On dry ground, Broad-leaved Willow-herb (*Epilobium montanum*) is the common species. In gardens and in shrubberies Rose-bay Willow-herb (*Epilobium angustifolium*) is often cultivated round water margins, it is very hardy, about 4 ft. high, and the stem terminates in a long raceme of dark rose-purple flowers, each 1 in. in diameter. The species hybridize very readily, and the hybrid progeny are of great interest to those who study questions of heredity. The common weed species are distinguished thus:

Great Hairy Willow-herb—an underground creeper, hairy, with a cylindrical stem 4 ft. high, large flowers over ½ in. in diameter, purple-red petals, and four-lobed stigmas. Small-flowered Willow-herb distinguished from the preceding species by its surface-creeping habit of growth, low stature (18 in.), and smaller flowers. Square stalked Willow-herb—a surface creeper, with square stem, glossy leaves, small pale-lilac flowers, and entire stigmas. Broad-leaved Willow-herb—distinguished from the preceding by its situation (dry ground), round stem, and four-lobed stigmas.

Willow-herbs are difficult to exterminate because of their creeping habit of growth and of their power of springing up from wind-sown seed. Drainage, of course, would be effective, but such procedure is not usually feasible. The best plan is to cut down the shoots as soon as they appear. If this is regularly done for two or three years, the plants will die of exhaustion, and at the same time spread by seed will be prevented. [A. N. M'A.]

Willow Weevil. See CRYPTORHYNCHUS LAPATHI.

Wilson, Sir Jacob, one of the best-known and most popular agriculturists of the 19th century. Sir Jacob Wilson was born at Creekenthorpe Hall, Westmorland, in 1836, his father

being an extensive farmer. After being educated locally and in London, he became a student at the Royal Agricultural College, Cirencester, at the age of eighteen. There he obtained a diploma in science subjects, and became honorary farm bailiff in the latter part of his time at the college. Later on he won the first agricultural diploma granted by the Highland and Agricultural Society of Scotland, and later still the special prize of the Society for the best report on the subject of reaping by machinery. In 1860 Mr. Wilson, as he then was, became a member of the Royal Agricultural Society, and was at various times a judge, a steward, and ultimately honorary director. In 1866 he was appointed agent on the Chillingham estates of the Earl of Tankerville, and later acted on other important estates. In 1868 he became secretary of the Northumberland Agricultural Society. Mr. Wilson was knighted by Queen Victoria in 1889, on the occasion of the Jubilee Show of the Royal Agricultural Society at Windsor. Three years later Sir Jacob retired from the honorary directorship of the Society in consequence of failing health, and was elected a life governor. Among the many services of Sir Jacob Wilson to agriculture was the exercise of his influence in promoting the passing of the Contagious Diseases (Animals) Acts of 1878, 1884, and 1896. In 1881 a testimonial and a purse of 3000 gs. were presented to Sir Jacob in recognition of his great services to agriculture. In 1892 he was appointed director of the Land Department of the Board of Agriculture and agricultural adviser to the Board. He was a Fellow of the Highland and Agricultural Society and of the Surveyors' Institution. In 1905, in an emergency, he acted as honorary director of the Royal Agricultural Show at Park Royal. Shortly afterwards the King conferred upon him the honour of Knight Commander of the Royal Victoria Order. Unfortunately he survived only a very short time after this honour was conferred. He died in 1905. [W. E. B.]

Wiltshire Cheese, generally known as Cheddar Loaf, is similar in size to the Stilton, but carries with it quite a different crust. The Wiltshire Loaf is of convenient size, but in one respect it is more wasteful than the Cheddar—it carries a relatively larger amount of crust, on the other hand, a large slice cut from a big Cheddar—for both cheeses are made on the same principle—if furnished with less crust, becomes dry, and in consequence less agreeable to the palate. Again, the smaller the Cheddar the smaller the proportion of mellow cheese, for as we get near the crust it becomes less unctuous. It is very seldom that in a competition or a fair a collection of Cheddar Loaves is equal to a similar collection of ordinary Cheddars.

In making a Wiltshire cheese the rennet is usually added to the mixed evening's and morning's milk at 80° F., the curd being brought in about an hour and heated in the process of 'cooking'—a local term which is scarcely appropriate—to 90° F. Ripening is conducted at as near 65° F. as possible. There are many makers who produce the Wiltshire cheese from partially skimmed milk. [J. Lo.]

Wind Damage to Woodlands usually occurs on a large scale in some part of the British Isles every ten or twelve years, and is increased by the fact that most of our woods and plantations are in small, isolated, unprotected blocks. Most of our heavy storms come as westerly winds, from S.W., W., or N.W., and are generally accompanied by heavy rainfall, but the greatest damage is occasioned in the woodlands when the wind veers round after heavy rainfall, and a gale (50 to 80 miles an hour) or cyclone (over 80 miles) comes from some other direction than what is usual locally. Storms cause both wind-breakage of branches and stems, and windfall of trees, clumps of trees, and whole woods, the trees being then torn up by the roots and thrown down to the ground. Though heavy gales prevail in March and September (spring and autumn equinox), the most destructive storms come during the winter, and of course evergreen conifers are then more exposed to danger than the leafless deciduous trees. Woods that have been heavily thinned are most liable to windfall, because the crowns of the individual trees are then unable to give each other the mechanical support afforded in fairly thick woods. The extent of damage that can be done depends not only on the force and direction of the storm, but also on the kind of tree, the age and density of the crop, its general condition of growth, the nature of the soil and situation, and the amount of recent rainfall. On level tracts, as along the seacoast, wind-breaks or protective belts of hardy trees (Sycamore, Beech, Elm, &c.) are very useful in sheltering the land behind them (see Shelter). [I. S.]

Wind Engines.—The windmills at present in use may be divided into two great classes: European and American. To the former class belong the oldfashioned types, of which the wind wheel consists of four or five huge vanes called sails, radiating from a horizontal or nearly horizontal shaft called the wind shaft; and to the latter belong the modern types, of which the vanes of the wind wheel are arranged in the form of an annular disk.

European Windmills.—The sails of these mills are commonly 30 ft. or 40 ft. in length, with a breadth of about one-fifth the radius, and are usually warped or slightly twisted like the surface of a screw.

A front elevation of the frame of a windmill sail is shown in fig. 1 and an end view in fig. 2. The arm or whip, C A B, is from 8 in. to 10 in. square at the shaft, and from 5 in. to 6 in. square at the outer end. The cross bars, which are light wooden rods, are usually from 15 in. to 18 in. apart, with the innermost, D, at a distance of one-sixth to one-seventh of the radius from the centre of the shaft. These cross bars, of course, are not set in the plane of rotation of the wheel but at an angle to that plane. This angle, called the 'weather' of the sail, should, according to Smeaton, gradually increase from 7° at the tip to about 18° or 19° at the innermost cross bar D, fig. 2. The sail frames are covered either with sailcloth or with a number of shutters or valves, *ggg*, fig. 3, hinged to the frame and connected together in such a way

that they open and shut like the bars of a Venetian blind. The latter method affords an excellent means of regulating the speed of the wheel under high wind pressures. When the valves are shut, they fill the spaces between the bars of the frame and form a continuous flat surface; as the axes of the shutters, however, are placed nearer to one edge, *g*, than to the other, the pressure of the wind tends always to blow them open against the action of the weight *w*, which, acting through the gearing and link-work shown, tends always to keep them closed. They begin to open usually when the wind

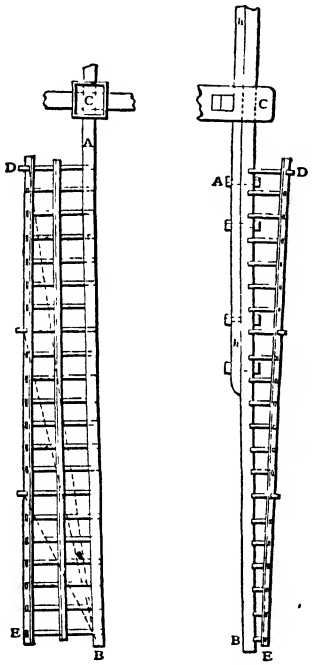


Fig. 1 Fig. 2

attains a speed of about 20 miles an hour; and as the opening increases with the speed, the surface of the sail exposed diminishes at the same time, and thus a constant effort of the wind on the sails can be maintained through a wide range of its speed. With canvas-covered sails, no self-regulating device yet proposed having proved satisfactory, the only way of adjusting the sail surface exposed to the load or wind is by stopping the mill and making the alteration by hand.

Of European windmills there are two chief types, viz. post or German mills, and tower or Dutch mills. In a 'post mill' the whole structure — sails, shaft, gearing, framework, and casing — is supported upon a fixed post or column, about which it is turned, when the direction of the wind changes, by means of a long horizontal lever attached to the casing. A 'tower mill', on the other hand, has a fixed tower surmounted by a cap to which the sails, wind shaft, and tail-vane are attached, and only the cap rotates. A vertical section of a tower mill is shown in fig. 4. The upper edge of the tower and the lower edge of the cap are provided with wooden curbs faced with iron rings. Between these rings there are interposed a number of metallic rollers or castors upon which the rotating cap turns; the axles of the castors being carried upon a third intermediate iron ring which serves to keep the rollers at a fixed distance apart. Round the head of the tower there is a circular rack which is connected by the gearing shown in fig. 1 to the fan F. This fan, which is carried by a bracket projecting from the back of the rotating cap, is so formed that it will not rotate when the direction of the wind is parallel to

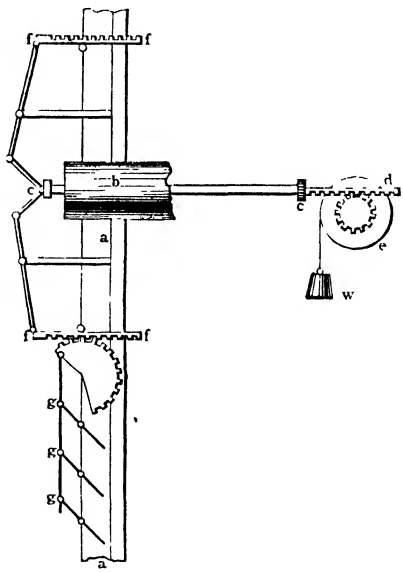
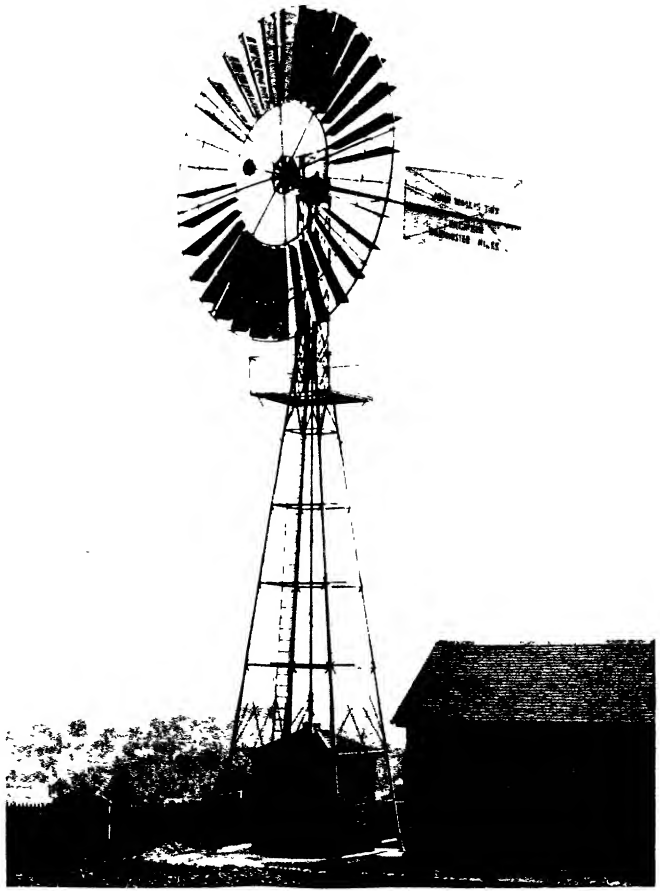


Fig. 3

its plane, but will immediately do so when the direction of the wind deviates therefrom. Suppose, therefore, that the wind changes from this direction; then the fan will begin to rotate and, by means of the gearing shown, will drive the pinion *e*, which, gearing with the circular rack, will cause the cap to rotate until the fan F is again parallel to the wind's direction and the sails almost perpendicular thereto. The motion of the sails, which are thus kept continuously square with the wind, is transmitted through the wheels *a* and *b* and the vertical shaft to the machinery. Such windmills were for a long period engaged in this country in grinding corn and in performing other work, but the vast improvements effected in the steam engine by James Watt caused them to be substituted by the steam engine to a very large extent, especially in flour mills.

American Windmills. — Of late years quite



WIND ENGINE DIRECT-ACTING TYPE

WINDMILL DRIVING A "SCOOP WHEEL" WATER LIFT FOR LAND DRAINAGE

a revival has taken place in the utilization of wind power, for the American or modern type of windmill, known as the '*wind engine*', is now used, chiefly for pumping, all over the world. In modern windmills, two examples of which are shown on the Plate, the sails are arranged in the general form of an annular disk, and the wind-wheel, shafts, gearing, and tail-vane are carried by a frame supported on the top of a high steel tower and around the head of which it rotates on ball bearings. When used for pumping, the wind shaft is connected to the crank shaft by spur gearing, which reduces the speed of rotation in the ratio, usually, of 2½ to 1, and the motion of this latter shaft is converted into the reciprocating motion of the pump rod, which extends downwards to the foot of the tower where the pump is situated, by means of a crank and connecting rod or their equivalent. In large power mills, however, the pump rod is replaced by a vertical shaft which drives the machinery through gearing situated, usually, at the foot of the tower.

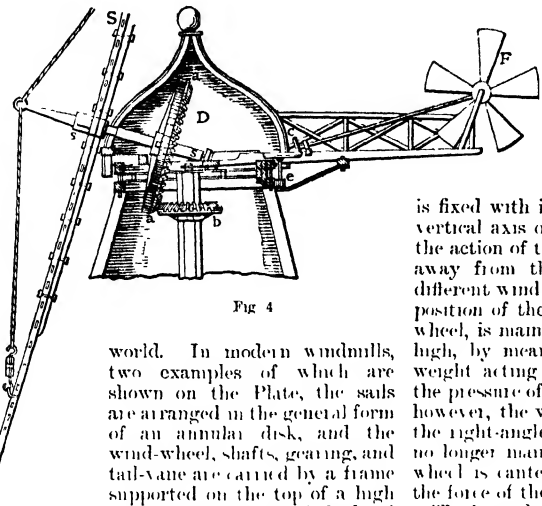


Fig 4

One of the most important features of a modern windmill is the governor. Many systems of governing have been tried, but those now in general use may be divided into two classes, viz., the canting wheel and the hinged vane. In the former class, which has been found the most successful for mills up to about 20 ft. in diameter, the governing is effected as follows.

The tail-vane, by means of a vertical spindle, is hinged to the rotating head, and (*a*) around the spindle a helical spring is wound, one end of which is attached to the spindle and the other to the head; or (*b*) between the vane and the rotating head a weight and lever are interposed.

The action of the tail-vane tends to keep the wheel facing the wind, but the wheel, which is fixed with its axis a little to one side of the vertical axis of the rotating head, tends, under the action of the wind pressure upon it, to turn away from that position, as shown, for two different wind velocities, in fig. 5. The normal position of the vane, viz. at right angles to the wheel, is maintained, when the wind is not too high, by means of the coiled spring, or the weight acting at the end of the lever. When the pressure of the wind exceeds a certain value, however, the weight or spring yields to it, and the right-angled position of vane and wheel is no longer maintained, with the result that the wheel is canted out of the wind, and receives the force of the latter with diminished effect.

The hinged-vane method of governing is similar to that adopted in the old-fashioned tower mill, and is only used for mills of the larger sizes.

In this method the vanes of the wheel are hinged in such a manner that, against the action of a weight or spring, they can yield to the wind pressure when it exceeds a certain value, and more or less present their edges to the wind, and thus diminish the area of the effective surface presented to the wind.

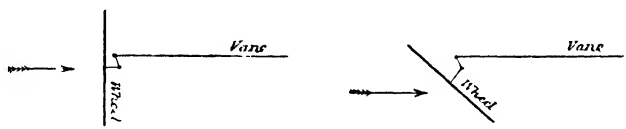


Fig 5

The approximate cost of modern windmills of various sizes, and of steel towers of various heights, are given in the accompanying table, together with the horse-powers the mills may be expected to develop under the circumstances stated.

Diameter of Wind Wheel in feet.	Gallons of Water raised 100 ft. high per hour with a 10 mile Wind.	Approximate H P that may be reckoned upon with a Wind varying from 15 to 20 miles per hour	Prices of Mills for Heights of— 30 feet			40 feet.			Prices of Steel Towers for Heights of— 30 feet			40 feet		
			£	s.	d	£	s	d	£	s	d	£	s	d.
7	80	—	17	0	0	18	0	0	15	0	0	19	0	0
10	200	—	22	0	0	23	0	0	18	0	0	24	0	0
12	350	—	30	0	0	31	0	0	18	0	0	24	0	0
16	600	1½	56	0	0	58	0	0	22	0	0	29	0	0
20	1000	2½	94	0	0	96	0	0	32	0	0	40	0	0
25	2000	4	120	0	0	126	0	0	45	0	0	53	0	0
30	3000	5½	182	0	0	193	0	0	75	0	0	106	0	0
35	4500	7½		—		265	0	0		—		100	0	0
40	6000	10		—		353	0	0		—		120	0	0

The above costs of mills when used for pumping include the pump suitable for the quantities given, the pump rod and guides, and for fixing at the surface, and when the mills are to be used for driving machinery, they include the vertical shaft, with bearings and bottom bevel wheels, and 10 ft. of horizontal shaft, also foundation bolts and plates

As windmills require very little attention, the cost of the power obtained thereby is almost entirely due to interest charges on the capital expended and depreciation See also Motive Power in Agriculture. [H B]

Windfall Timber should be barked and removed from the woodlands as soon as possible. This is especially necessary in the case of conifer timber, which very soon becomes infested with bark beetles that breed in myriads in the bark and cambium and then attack growing trees If the timber cannot be removed at once, it should at any rate be barked to prevent any such infestation. While any extensive wind fall increases the necessity for rapid removal and conversion of the timber, it at the same time renders its sale more difficult. Destructive gales like those of November, 1893, in Perthshire, and of February, 1903, in Ireland, which threw several millions of trees, not only glut the market locally for the time being, but prices obtainable sink at once, as the wood merchants know that the landowner must clear the timber as soon as possible Large windfalls are most likely to occur after continuous heavy rainfall, when the roots have a weaker hold than while the soil is dry. The best way of preventing windfall is to arrange the annual falls in regular series, proceeding in the direction opposite to that from which the most dangerous wind is to be feared (see Woodlands, Management of) But in practice this can only be arranged for in the case of large compact blocks of woodland, and even then it cannot provide complete safety for cyclonic action of the wind, such as often produces heavy windfall. [J. N]

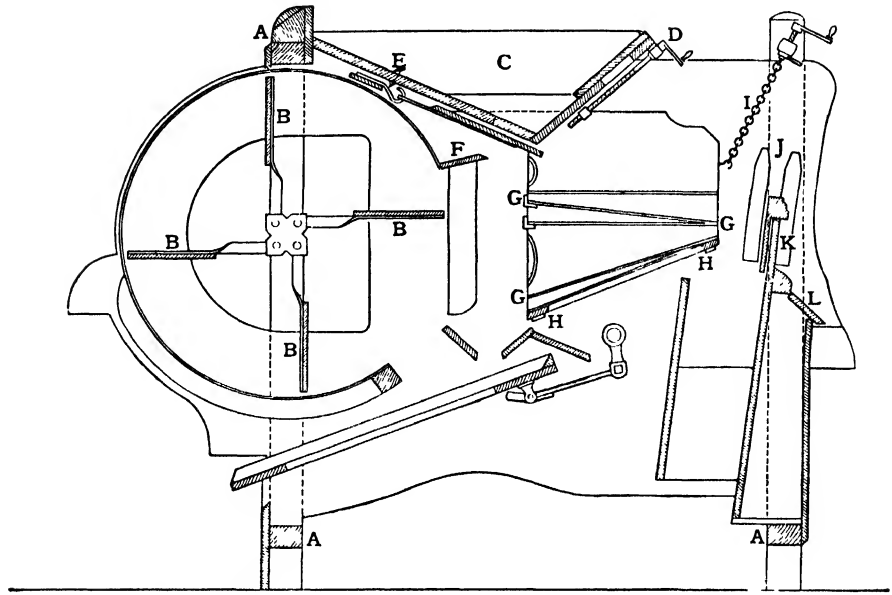
Wind-galls.— The puffy swellings about the fetlocks and other places where little oil sacs or bursæ are interposed to prevent friction are commonly called wind-galls. They do not contain air and must not be opened. Most horses acquire wind-galls if they do much service. A primary inflammation of the secreting membrane leads to increased activity, and a more or less dropsical fluid results. They often attain to a certain size, and remain at that without causing lameness or inconvenience—merely detracting from the appearance of the limb. In a few instances chronic inflammation leads to tissue changes and consolidation, when they may press upon sensitive parts and induce pain and lameness. *Treatment*—A moderately tight bandage at night causes their diminution, or entire disappearance if of recent origin, but the filling recurs when the pressure has been removed a short time. Blisters have a more lasting effect, but there is no permanent cure. [H. L.]

Windmill. See Wind Engines.

Wind-sucking.—This objectionable habit is often a later development of crib-biting (which see), and is thought to arise from indigestion, from ennui, and heredity. The horse takes hold of any solid object with his teeth, and draws air into his stomach until the sides are distended. Flatulent colic and other digestive troubles are the frequent result, but some subjects of this so-called 'vice' do not suffer ill consequences for a long time. The animal's value is much depreciated by it, as his pace slackens, and fatigue is more easily induced There is but one remedy for a confirmed wind-sucker, and that is a tight strap round the throat [H. L]

Winnowing, and Winnowing Machines.—Winnowing, strictly, is the separation of chaff and other impurities from corn and seeds by the agency of wind, and, as in some countries at present with a primitive farming, natural wind was mainly relied upon in England until comparatively recent times Even on good farms up to within the past fifty years, a simple blower, consisting of a spindle carrying an unenclosed skeleton frame, to which sheets were attached to produce a blast to act upon corn thrown up before it, might occasionally be seen as a relic of the days when machines of modern type were unknown Crude machines were used before the middle of the 18th century, but in 1800 Cooch brought out his winnower, which also contained sieves, and from that time combination machines have been generally used With very little alteration Cooch's machine is still largely used to-day, and it is the only machine which separates light kernels from heavy ones by wind action, although machines of more recent introduction blow out markedly lighter impurities, relying on sieving to a greater extent to make divisions according to size With the Cooch machine steady turning is essential, because on the regularity of the blast depends the uniform head and tail separation. In the modern machines although regularity is desirable it is not so absolutely necessary A common error in cleaning corn is that of keeping the corn too long on the sieves, that is, of not running enough over them at once If corn is allowed to remain on the sieves all coarse impurities are not swept over the edge, but the reciprocation of the sieves ultimately causes them to find a position which allows them to drop through In all sieve work there should be a considerable quantity of toppings run off, and these toppings should be separately treated to get out the grain suitable to go with the bulk. [W. J M]

Winter Herding Act. -By ancient custom which obtained on both sides of the border, it was obligatory on the owner of cattle to prevent them from straying so as to injure artificial crops, but this applied only 'in haaning time while the corns are upon the ground'. After the crop had been cleared, the ground either became common or the owner had to herd his own ground, and might turn off his neighbour's stock without doing injury to them. If the trespass took place during the time the crops were on the ground, the owner on whose ground they had trespassed was entitled to hold the cattle in security of the damage done, and to detain so many of them as would indemnify



Section of Winnowing Machine

A, A, A, Crossbars to frame B, B, B, B, Fan boards C, Hopper D, Regulating screw to hopper E, Board carrying hook for middle case F, Wind deflectors G, G, Loose straps H, H, Ironwork straps I, Riddle case chain and adjusting screw J, Slides K, Wind check sliding board. L, Lid to riddle box.

him for his loss In order to extend to this custom the sanction of law and to make the protection apply to all ground and all seasons, the Winter Herding Act of 1686 was passed. It enacted that 'all heritors, liferenters, tenants, cottars and others possessors of lands and houses, shall cause herd their horses, nolt, sheep, swine and goats the whole year, as well in Winter as in Summer, and in the night-time shall keep the same in houses, folds or enclosures so as they may not eat or destroy their neighbour's ground, woods, hedges, or planting; certifying that such as shall contravene, they shall be liable to pay half a merk' [that is, 6½*d*], '*toties quoties*, for ilk beast they shall have going on their neighbour's ground, by and attour the damage done to the grass or planting; and that it shall be lawful for the heritor or possessor of the ground to detain the said beast until he be paid of the said half a merk for ilk beast found upon his ground and all his expense in keeping same'. This Statute, although it has been said to be unsuited to the present day, is still in observance and is liberally construed. The right to detain until the statutory penalty and expense have been paid, has been extended in practice to obtaining security for the compensation due for damage done. Damage may be either to corn or to grass or planting.

In order to secure the right to claim payment, it is not necessary to detain the trespassing cattle; but if they are detained, the detention must be before the cattle have left the ground on which they are trespassing. It has been decided that it is not competent to sue for the statutory penalty in the Small Debt Court This Act applies only to Scotland. [D B]

Wintering Cattle and Sheep.—CATTLE.—In wintering cattle, or carrying them on from one pasture season to another without fattening them, the main object, namely, to keep them growing and thriving on the cheaper foods of the farm, must be kept continually in view The methods of wintering cattle vary with the climate and the locality. In the south of England and in Ireland store cattle are often wintered on rough pasture, with an allowance of meadow hay and a shelter shed for bad weather. In some cases in the mildest climates they winter on pasture only. In the north of all three countries of the United Kingdom, however, wintering cattle are generally housed; and without doubt they thrive best when loose in courts, partly closed or completely closed according to the district and the aspect of the farm. Closed courts if sufficiently ventilated are probably the best, on account of the superior quality of the dung obtained, though partly-open courts are a better preparation for the following exposure on the pasture in the spring. It does not follow, however, that cattle kept under rigorous winter conditions will do better afterwards on the grass, rather the contrary. If the store cattle are kept in courts they must, as a rule, be dehorned to prevent bullying or possible injuries. As dehorning is illegal in England, all calves intended for wintering should have the horns killed out with caustic potash when a few weeks old.

The wintering of cattle can only be profitable if the cheap and bulky foods of the farm provide

the chief ration. Turnips, swedes, mangels, hay and straw, are therefore the proper foods. Cattle from six to twelve months old require about 1·2 lb of albuminoids and 7·5 of non-albuminoids per day, with an albuminoid ratio of 1 6 per head per day, and those quantities are not supplied in the common ration of turnips and straw given to cattle of that age. It is therefore desirable to restrict the quantity of turnips, and to endeavour to induce the animals to eat more straw, or hay if it is cheap Probably the most effective system of wintering stirks is to give them all their food pulped and chaffed, partly because it is possible in this way to induce them to eat damaged hay and straw in larger quantities than if they were allowed to pick and choose, and partly because the condition of their teeth prevents them from breaking up whole or even sliced turnips effectively.

The choice of a ration depends on the price of cattle and the supply of turnips If the latter are abundant and oat straw of good quality is available, it will pay better to feed on such a one sided ration at the expense of the growth of the stock, rather than make the most of them with a more expensive diet The most effective compromise is to use pulped turnips mixed with large quantities of chaffed straw, sweetened with treacle water and enriched by a pound or two of some highly albuminoid food such as cotton-seed meal. A mixture of 20 lb swedes (which is much less than the usual quantity), 12 lb oat straw, and 2½ lb cotton-seed meal, or Soya bean cake, would provide the necessary ingredients in the proper proportions Whatever the food, it should be given at regular intervals three times a day If turnips and straw are fed separately, a feed of straw should commence the day, followed by turnips, and the cake given instead of turnips at midday Care should be taken to give only such a quantity of turnips as the cattle will clean up at each meal, but the racks may be kept filled with straw

The cost of wintering cattle of six to eight months old is stated by Dr Shirra Gibb, of Boon, Lauder, as follows —

Wintering 180 Days

	£	s	d
Turnips, 28 lb, 1½d per day .	1	2	6
Cake and meal, 2 lb .	0	15	0
Straw, hay, and attendance ...	0	15	0
	2	12	6

The cake and meal are estimated at less than £5 per ton, and the turnips cost 10s. per ton A convenient figure for estimating the cost of wintering young cattle is 10s per head per month, from which must be deducted the value of the manure

Sheep.—Sheep which have to be wintered are of three classes the lambs or hoggs of hill flocks, for which the hill pasture is too exposed, insufficient, or foul with louping-ill or braxy, to which young sheep are more susceptible than older ones. The second class comprises low-country sheep of inferior grades, such as poor-quality half-breds or crosses too thin to fatten in the winter without heavy food expenditure. The third class includes all ewes in lamb, but their treatment is specially dealt with in other articles.

Hill sheep which winter in the low country are often accompanied by their shepherd, who takes them from farm to farm as the foggage or rough pasture fails. Other wintering flocks are delivered to the farmer, who keeps them over the whole winter As a rule, wintering sheep of the hill breeds feed on what they can pull, except in a snowstorm, when they are given hay, and perhaps some turnips In open weather their food is varied, they take toll of all the grass fields on the farm, wander over stubbles, and graze along the hedges and fences until spring, when they return to their native hills The cost of sending hoggs away to be wintered is 6s or 7s per head Wethers which have not come off the hill fit for the butcher are often sent away to be wintered on turnips and finished on the following grass. As a rule the wethers get nothing but turnips, with an occasional bite of hay in hard weather The second class of wintering sheep, low-grade half-breds and crosses, are also wintered on turnips, or in mild open climates they may get most of their living from the grass fields Wherever sheep are wintered they should have access to shelter. A plantation, a hedge, or a stone wall will help them not a little in stormy weather A successful and profitable method of wintering cross- and half-bred ewes is much in vogue in the north of Scotland A farm of 200 ac may carry a breeding flock of 200 ewes or more, but instead of maintaining the ewes during the winter on the produce of the farm, they are sent in charge of a shepherd to range over a wide area, moving from farm to farm as they exhaust the available pasture of the farmers who do not keep sheep themselves, but let their grass at so much per head per week. In the spring the flock returns to the owner's farm for the lambing, and grazes there during the summer. Although the cost of wintering is heavy, about 10s per ewe, this system prevents the farm from getting foul, as it would if so heavy a stock were kept all the year round, leaves the turnips for the cattle, and provides profitable stock for the summer pasture.

[R B G]

Winter Manuring.—The term 'winter manuring' is applied to the practice of putting manures on the land in the autumn and winter months instead of in spring Much difference of opinion prevails among farmers as to the relative merits of the two methods of application The question may be most conveniently discussed separately in relation to farmyard manure and to artificial manures

The practice of applying farmyard manure during autumn and winter to land intended for root crops is a comparatively modern one The usual procedure is to cart out the manure to the corn stubble and then plough it in, either at once or some months later with the ordinary plough, but in some cases the stubble is first ploughed, and the dung then carted out in frosty weather and spread on top of the furrows. The latter practice has this advantage: ploughing can be proceeded with at once after harvest, and the manure applied at convenient times

thereafter; whereas in the former method the benefits of early stubble ploughing are lost, either through waiting until the manure is made, or until conditions permit of its application to the land.

In forming an estimate of the adaptation of winter manuring to the conditions of present-day farming, it requires to be borne in mind that by far the greatest proportion of farmyard manure is produced from about the beginning of October to the end of May, and only a relatively small quantity during the other months of the year. There can be little doubt with regard to the manure produced in the early months of the year, from January till the time of seed sowing and planting in April and May. The manure made in these months, unless under very special circumstances, ought to be applied in spring, in order to avoid the heavy losses that would necessarily be incurred in keeping it over till the following autumn. Only the manure stored throughout the summer is available to be applied in autumn, while only that made from October to December is available for application in winter, unless on the top of the ploughed stubble. It follows from this, that one of the main factors in the economy of winter manuring is the extent of the losses which the manure is liable to undergo during storage in the heap. The most obvious change which goes on is the reduction in quantity, and the extent of this is conditioned by the manner in which the manure is stored. Generally, the more compact the heap is made and the better it is protected the less will be the loss in weight, but in few cases will it be less than 20 per cent, where the manure is stored for about three months under ordinary conditions on the farm. There is also a marked change in the quality of the manure. A certain proportion of the carbonaceous substance disappears, and there is consequently an increase in the proportion of nitrogen, phosphoric acid, and potash. At the same time there is an increase in the proportion of soluble and readily available mannial ingredients. In other words, the manure becomes at once concentrated and more active. In one experiment, 10 tons of dung in the fresh condition was found to contain 87 lb of nitrogen, while an equal quantity of the same dung when rotted contained 112 lb. Numerous experiments have proved conclusively that the loss of nitrogen in farmyard manure kept for about three months under the very best conditions for storage amounts to not less than 15 per cent of the amount originally present, and in many cases it will be double that amount—the loss being greatest in open, badly-made heaps and in summer, and least in well-made thoroughly compact heaps and in winter.

With regard to the losses which the manure may undergo after application to the land during autumn or winter, no actual figures are available. But, on theoretical grounds, it may be concluded that, unless on very light porous soils and in very wet seasons, they are not likely to be very serious. The loss, if any, will fall chiefly upon any nitrates which may be produced, and it is known that in our climate the nitrification processes go on very slowly during the winter months. Even fresh manure, however, may contain some soluble nitrogenous ingredients, and during heavy rains on open soils these are no doubt liable to be washed out and lost. Also, if a period of dry weather should succeed the application of the manure on the surface without ploughing down, it is probable that some loss of ammoniacal compounds might be incurred. It may be assumed that there will be no appreciable loss of phosphoric acid or of potash.

Apart from the question of the effects of the manure upon the chemical condition of the soil, its effects upon such physical properties as texture, and water-holding capacity, must also be taken into account, while the influence of climate requires also to be considered. It seems apparent that the best time for applying farmyard manure to light soils may not be equally suitable for stiff clays. But even on the light soils, practice varies in different parts of the country for reasons that are obviously sound. In the cool and moist climate of western and northern Britain, farmyard manure is very commonly applied in the drills in spring to the turnip crop, and very heavy crops are grown. In the drier climate of the south and east of England this method is found to dry the land too much, and the ridges are also left too open as the manure decays in them. On these dry soils it is found better to apply the farmyard manure in autumn, and the land benefits by its greatly increased power of retaining moisture till the period of seed sowing and plant growth. How important is this effect may be judged by the result of an experiment by King, who found that land enriched with farmyard manure held 18 tons more water per acre in the first 12 in. and 6 tons more in the second 12 in. than similar soil to which no farmyard manure had been applied. Such an effect, however, would obviously be of little or no value in a wet climate, while on clays and soils naturally sufficiently retentive of moisture it would be of no advantage. On the other hand, on such stiff clays the influence of farmyard manure on the texture of soils is of much value, and the application of the manure in its fresh condition while the straw is still undecayed is distinctly to be preferred. If ploughed down in autumn it has a very beneficial aerating effect and assists the ameliorative winter processes, while if applied in the drills in spring it keeps the soil open and greatly facilitates the development of a large and wide-spreading root system.

A number of field experiments have been made for the purpose of determining the relative value of the fresh manure applied in autumn as compared with the rotted manure applied in spring as shown in the produce of crops. Reports of these experiments are to be found in the Highland Society's Transactions and other journals, but without exception they have been valueless for the specific purpose for which they were designed, because the experimenters have compared equal weights at the time of application instead of at the time of making. The question is, not whether 20 tons manure ploughed

in on the stubble in autumn will give a greater or less crop than 20 tons applied in the drills in spring; but whether, if the 20 tons available in autumn be kept till spring, what remains of it after the losses incurred in storage will give as much return in crop as would have been obtained from the manure had it been applied in its fresh and full quantity in autumn.

If, for example, 20 tons of fresh farmyard manure are applied in November and ploughed in, and 20 tons of well-rotted manure of the same kind put in the drills in the spring, the latter dressing may contain the larger amount of the valuable manurial ingredients, but the returns are not properly comparable, because no account is taken of the value of the nitrogen and the organic matter which have been lost during storage. The 20 tons applied in spring may be the equivalent of 25 tons or more that was available for application in winter; and the question a farmer has to determine is, not whether 20 tons applied in November will give as good returns as 20 tons applied in April, but whether the 20 tons in November will not give better results than its residue, amounting perhaps to 16 tons, would if kept for late-spring application.

The results of a rotation experiment designed and conducted by Professor Wright at the West of Scotland Experiment Station, Kilmarnock, from 1902 to 1906, in which these considerations were kept in view, as reported by Professor Berry in the College Bulletin No. 38, showed somewhat contradictory results. Two of the main objects of this experiment were 'to show the effects of different methods of using fresh farmyard manure, namely (1) to apply it broadcast in the autumn, and (*a*) plough it in at once, (*b*) leave it spread on the surface some months before ploughing in, and (2) to apply it in drills at seeding time in spring'; and 'to observe the influence of each method on the succeeding crops in the rotation'. A further object was to compare the effects of fresh farmyard manure after rotting (*a*) in a heap in the field, and (*b*) in a heap under cover. Two different four-course rotations were tested, namely: (1) potatoes, wheat, seeds, oats; and (2) turnips, barley, seeds, oats. The winter dressing was put on about the middle of January, and either ploughed in at once, or left for two months on the surface and then ploughed in. The soil is a light loam, and the spring months in the first year of the experiment were exceptionally dry, so that little loss would be incurred through washing out on the winter-manured plots. In the potato rotation the plot in which 20 tons of fresh farmyard manure were ploughed down in winter gave a profit of £1, 1*s.* 2*d.* per acre, as compared with £1, 16*s.* 8*d.* from the plot receiving the residue of 20 tons of fresh farmyard manure after rotting in the field. According to these results it is more economical to store the farmyard manure during winter and apply it in spring than to apply it in winter and plough it in. But when we turn to the turnip rotation we find that exactly contradictory results were obtained. Here the plot which received 20 tons of fresh farmyard manure ploughed in at once gave a return per acre of 5*s.* 11*d.* more than the plot which had received in the drills the residue from 20 tons of fresh farmyard manure rotted in the field. The results from the various methods of treatment may be summarized thus:—

	+ Profit or − Loss, per acre per annum					
	Potato Rotation.			Turnip Rotation.		
	£	*s*	*d*	£	*s*	*d.*
20 tons farmyard manure applied in winter and ploughed in at once	+1	1	2	−0	11	3
20 tons farmyard manure applied in winter, but not ploughed in for two months	+0	15	10	−0	7	5
Residue from 20 tons fresh farmyard manure applied in drills after rotting in the field	+1	16	8	−0	17	2
Residue from 20 tons fresh farmyard manure applied in drills after rotting under cover	+2	3	8	−0	17	5

The actual weight of the residue from the fresh dung amounted to 16·6 tons when rotted under cover, and 16 tons when rotted in the open, so that by storing the manure till the spring, between 3 and 4 tons per acre of valuable organic matter was lost, including a considerable loss of nitrogen. According to these results, the larger potato crops and the better returns for the whole rotation were obtained by storing the manure in the winter and applying it in the drills. But in the turnip rotation, while the larger turnip crops were also obtained from the spring manuring in the drills, the returns from the whole rotation were greater from the manure applied in the winter and ploughed in. But the results of a single experiment cannot be considered conclusive even on similar soils, and they cannot be regarded as applicable to different conditions of soil and climate.

The practice of applying farmyard manure so far as it is available to stubble fields in autumn before ploughing them up has now, however, become very general. The chief reasons in its favour are: (1) The total quantity of manure is greater and can be more widely spread over the fields; (2) as the manure is applied to the land in its fresh condition the losses incurred during storage are obviated; (3) the expense and practical difficulties attendant on its careful storage are avoided; (4) the land can be more easily worked in spring, owing to the ameliorative effects of the organic matter of the manure; (5) potatoes and turnips are believed to be less liable to disease and to keep better when grown on the autumn-applied manure; (6) potatoes especially are believed to be of better quality; (7) congestion of labour is diminished in the busy spring sowing season. The latter advantage is the one which most largely, and rightly, determines farmers in favour of the autumn application of the manure. The frequent urgency of spring work in wet and inclement seasons makes it a matter of paramount importance that every farm operation capable of being done earlier in the year should be completed, so that nothing may retard the processes of seeding and keep them to a later date than is suitable. The cartage of large quantities of farmyard

manure involves labour which in some unfavourable seasons might cause a disastrous delay in the seeding or planting of the crops; and even if it were established that spring manuring gave the larger yields of crop, the advantage so obtained might be much less than the losses incurred through the retardation of the seeding. Moreover, the carting out of the manure in autumn and winter can be done more easily and expeditiously during periods of frost, while the fact that it gives employment to men and horses when other field work is unavailable renders it alike convenient and economical.

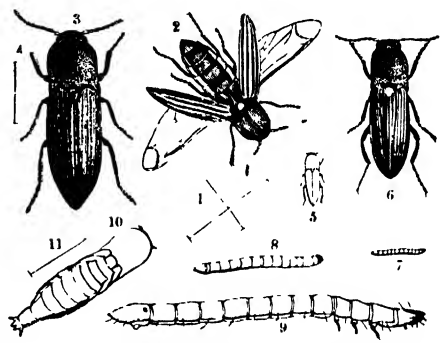
The winter application of artificial manures is now chiefly confined to grasslands, either permanent pasture or land intended for hay; and the only artificial which is applied to any extent at this time is basic slag. This manure contains the phosphate of lime in a more slowly available form than superphosphate, and unless it be applied not later than December or January its full effects will not be apparent until the second summer after application. Besides, if applied in winter when the grass is barest, it is more readily washed down into the soil, and so exercises its ameliorative effects more rapidly. Slag can be used as a winter topdressing for several purposes, but it is most largely used on poor permanent pastures. It gives the best results upon stiff clays and upon peaty soils, and in the latter case it will usually be profitable to sow a few hundredweights of kainit along with it, a common dressing being 10 cwt slag and 8 cwt. kainit per acre applied in the early winter.

At one time it was held that slag ought also to be applied broadcast in winter on land intended for root crops, in order that it might have time to become available to the growing crops; but numerous experiments have conclusively proved that under most circumstances the slag gives the greatest return when applied in the drills in spring. Thus in experiments conducted by the West of Scotland Agricultural College the average increase of turnips from the spring-applied as against the winter-applied slag on farms in the centre and south-west of Scotland during 1904 and 1905, was 2 tons 11 cwt. per acre on sixteen farms out of twenty-two When the slag is applied broadcast, only part of it ever comes into contact with the turnip roots; and it appears that the advantage through having the whole of the slag concentrated in the drills immediately beneath the plants more than counterbalances any disadvantage there may be on account of its want of solubility. In the case of cereals, grass, &c., the roots ramify through the whole of the soil, and hence the more completely the slag is spread over the whole surface the more effective it will be. Another point of difference between grasslands and root crops may be noted in connection with kainit. This manure contains about 35 per cent of common salt and about 30 per cent of magnesium salts; and it is found that for clovers it is very advisable to apply it during the winter, in order that these stuffs may be washed out or rendered innocuous before spring growth commences. For potatoes also, kainit should always be applied in winter, otherwise the quality will be much injured by the magnesium salts present; but in this case, other potash manures applied in the drills are more economical. For other crops—cereals, mangels, and turnips—kainit will generally give the best returns when applied in the spring.

As regards the other artificial manures, those containing the readily soluble forms of nitrogen, potash, and phosphoric acid should always be applied in spring or early summer, while mineral phosphates, bone meal, bone flour, &c, may be applied in winter or spring according to the principles outlined above, namely, in the spring for root crops, but in winter for grasses, cereals, &c. For best time to apply lime, see arts. Lime and Liming. [R. P. W.]
[J. W.]

Winter Moth. See Cheimatobia brumata.

Wireworms.—The true wireworms are the larval stage of the click-beetles or skip-jacks,



1, 2, Striped Click beetle (*Agriotes lineatus*), 3, 4, *A. obscurus*, 5, 6, *A. sputator*; 7, 8, Wireworms, nat size, 9, magnified, 10, 11, pupa

so-called 'claters' which lay their eggs in fields, gardens, and woods. These eggs give rise to the wireworms, which later change to pupæ, and from these another brood of click-beetles appear.

The female beetles (see art. Agriotes) place their eggs either upon or beneath the soil, especially choosing places covered with thick vegetation; the eggs are quite small, oval, and yellowish-white to brown.

The young wireworms coming from these eggs are very small, only just seen by the naked eye. They at once attack the roots of the nearest plants, whether wild or cultivated. These ravenous larvæ attack corn of all kinds, all root crops, pulse, grasses, potatoes, cabbage, hops, and most garden produce and flowers. They continue to feed and grow for from three to five years, during which period they moult their skin several times. Typical wireworms are shiny yellow, pale-yellowish-brown to deeper brown; their form is more or less cylindrical, but flattened below; the head is hard and horny, and provided with strong biting jaws; on the first three rings of the body are three pairs of jointed legs, and there is a ventral prominence on the last segment. In size they vary according to the species;

some reach nearly an inch in length. The above characters will at once separate them from any other grubs found in the soil attacking plants. At times they tunnel deep into the earth, but as a rule they prefer to work close to the surface. Now and again we find them ascending into the stems of plants and eating their way right into tubers and roots. In very cold winters they go deep down and do not feed much, but in mild ones they keep on eating right through the year. They can move with considerable rapidity in loose soil. When full-fed, which is generally in May and June, they make oval cells deep in the earth and change to pale pupæ, and in from two to three weeks they hatch out as perfect click-beetles and come out of the ground. They have many natural enemies. Rooks, starlings, the green plover or lapwing, pheasants, partridges, gulls, and poultry feed upon them. Moles also do much good in keeping them numbers down. Curtis records that the Ground Beetle (*Steropus madidus*) feeds upon them, and probably many more Carabidæ do also. A small hymenopterous fly (*Proctotrupes cator*) lays its eggs in wireworm, as many as twenty to thirty in each victim, these ova produce maggots which feed on and kill the wireworm. True wireworm must not be confounded with false wireworm or Iulus, one of the millipedes. See Myriapoda.

Prevention and Treatment. There does not seem to be any known substance that can be used on a large scale that will kill wireworm in the soil. Vaporite and such like substances will drive them away *pro tem.* In garden cultivation they can be destroyed on a small scale by injections of disulphide of carbon when the soil is fairly dry, but the process is too costly for field cultivation. The beetles may be trapped in numbers, and so prevented from laying their eggs, by placing small heaps of clover or lucerne about the fields or gardens covered over with a board or tiles. The click-beetles shelter there, and may often be collected in large numbers during the day and destroyed, thus saving thousands of eggs from being produced. This should be done through May, June, and early July. The larvæ may also be trapped in gardens and hop gardens by placing pieces of mangold, carrot, beet, or potatoes under the soil near the plant centres. These traps can be examined every now and again, and the wireworm picked out and killed. Clover ley and grassland are always full of these pests. Before either is broken up, the herbage should be fed off by sheep, which should be thickly penned on the land and artificially fed. Refuse herbage is thus all destroyed, and the droppings and urine make the land obnoxious to insect life, and the trampling of the sheep consolidates the soil and so prevents the wireworm from moving about. The land should next be dressed with lime or soot, then ploughed up, and a crop of mustard grown. When the latter is half grown it should be fed off, partly by sheep, and the stalks ploughed in, or it may be ploughed in direct. Attack may be prevented by drilling the artificial manures with the seed. In Essex this has been found most successful, the manure driving the insects between the drills, where they had to feed upon the weeds. When young corn is attacked, rolling with a ring roller does much good, for it consolidates the soil and the wireworm cannot travel so fast. This should be followed by a dressing of soot or nitrate of soda and so hasten the plant through its vulnerable period. Superphosphate on roots acts in a similar way. Neither lime, gas lime, salt, nor soot has any direct effect in killing wireworm. These pests may be drawn away from a crop by the use of rape or mustard cake, but this does not do what is popularly supposed, namely kill them. On the other hand, this substance attracts the click-beetles, so that it is of very doubtful benefit. Heaps of manure, leaf mould, &c., should never be allowed to have weeds growing on them, these attract the click-beetles, and the wireworm feed on the weed roots and thus get carried to the field and garden. The heaps should be covered with a good layer of mould and lime or gas lime. Clean farming, frequent moving of the soil, rolling, sowing manures with seed, trapping, and suitable manuring are the only things that will lessen wireworm attack. [F. V. T.]

Wistaria, a small genus of very ornamental, hardy, climbing, deciduous shrubs, with blush and white flowers borne in racemes, natives of China, Japan, and North America (nat. ord. Leguminosæ). The sorts cultivated in gardens are *W. chinensis*, which has dense racemes of fragrant mauve flowers, and its varieties *flore albo*, *flore pleno*, and *foliis variegatis*, and *W. multijuga*, which has longer racemes of mauve flowers, often exceeding 2 ft. in length, and its white-flowered form. Wistarias make rapid growth in good loam, and will quickly cover a building. They should be pruned after flowering. They seldom ripen seeds in this country, but are readily propagated by layering. [W. W.]

Withers, Fistulous. See Fistulous Withers.

Woad (*Isatis tinctoria*, L.), a biennial herbaceous plant belonging to the nat. ord. Cruciferæ, is an indigenous plant met with most frequently as an escape from former cultivations. It has an upright stem 1 to 3 ft. high, branched above, and bearing glaucous, narrow, sessile leaves, those near the ground being oblong lanceolate with long petioles. The flowers are many, small, and yellow, of the ordinary cruciferous type, the pods are one-seeded, drooping, pouch-like structures about ½ in. long.

Woad has been grown from the earliest times in Britain for the sake of its leaves, which contain indoxyl, an unstable compound whose watery solutions produce indigo-blue after treatment with an alkali and an acid. It is probable that this is the plant which is mentioned by Cæsar, Pliny, and other Roman authors as being employed by the ancient Britons for staining their bodies. Since the introduction of indigo from the indigo plant (*Indigofera tinctoria*) in the 16th century the cultivation of woad has almost disappeared. Small quantities, however, are still grown in Cambridgeshire and Lincolnshire; and although the manufactured product obtained from the crop is no longer utilized by itself for dyeing, it is employed as an adjunct in the dyeing of blue and black fabrics with indigo, render-

ing the colours obtained from the latter dye more stable or fast against the action of rain, salt water, and sunshine.

The crop can only be grown successfully on rich, well-drained loams, recently broken-up old grassland, and alluvial tracts bordering rivers being most suited to its cultivation. The seed may be broadcasted at the rate of 2 or 3 bus. per acre, or drilled in rows 8 to 12 in. apart, 1 bus being then sufficient. In order to economize labour in its management it is usual to sow it at short intervals from March to May The young plants are thinned when about 2 or 3 in high, the crop at the same time receiving a thorough weeding. In July the first crop is ready, when the plants are from 8 to 12 in high The leaves are then twisted off the stem in such a manner as to leave the latter unmjured, and capable of producing another crop about six or seven weeks later; a third smaller collection of leaves may be made in favourable seasons In the following spring the plants are allowed to grow up and produce seed, which ripens in June or July

In the preparation of woad from the gathered leaves, the latter are first ground or crushed into pulp by means of large vertically placed wheels which go round on a specially prepared granite or iron floor. The pulp is placed in small heaps to drain, and then worked up by hand into oval lumps or 'balls' from 4 to 6 in in diameter, these are carefully dried in airy sheds During winter the dry 'balls' are broken again by the pulping wheel into coarse powder, which is subsequently spread out on a 'couching' floor to a depth of 2 to 3 ft, where it undergoes a fermentative process The regulation of the temperature of the woad during fermentation is of the greatest importance, and requires much skill and experience to obtain a sound product After the fermentation is complete, the powder is stored tightly in barrels and sent to the dyer [J F]

Wolfsbane, the name commonly applied to Aconite on account of its excessively poisonous properties See art. Aconite

Wood, Structure and Composition of. See art Timber

Wood Ashes, the incombustible (mineral) matter remaining when wood is burned The percentage of ashes obtained varies with the kind of wood, as well as with the part of the tree from which the wood is obtained. The ashes of leaves may amount to 15 per cent of the dry matter. Sapwood may contain nearly 3 per cent, bark 7 per cent, while the heartwood may contain only 5 per cent. Generally it may be taken that the more herbaceous the plant the higher the percentage of ashes. The important constituent of wood ashes (from an agricultural point of view) is potash The percentage of potash in wood ashes varies, some investigators naming 5 to 25 per cent as the extremes. Generally about 8 per cent is present. Wood ashes also contain about 1·5 per cent of phosphoric acid. As a manure, wood ashes have been used for hundreds of years Their effect is largely due to the potash present, but the carbonate of lime and phosphoric acid present have also some manurial value As a topdressing for grassland they are valuable as they promote the growth of clovers, and in some countries they are still collected for this purpose. In former years, wood ashes were the chief source of 'potashes', which on purification gave 'pearl ash'. They were also largely used in the formation of composts, thus providing the base necessary for the fixation of the nitric acid produced in these so-called artificial 'nitre beds' Since the introduction of potash salts from the Stassfurt deposits in Germany in 1861, wood ashes have fallen into disuse in England [S A W]

Wood-boring Beetles. - Under this category are generally included only those beetles which live on dead wood, but the following list embraces some which live on standing timber as well *Agrilus viridis*, *Cryptorhynchus lapathi*, *Hylobius abietis*, *Pissodes notatus*, *Scolytus destructor*, various species of the family *Tomicini*, *Xyloborus dispar*, *Hylurgus piniperda*, *Hylesinus*, *Saperda carcharis*. Two species, *Anobium domesticum* and *Xestobium tessellatum*, commonly called the 'Death watch Beetles' from the curious ticking sound which they produce, excavate tunnels in the wood of furniture, timber work of old houses and churches, and also old standing trees. See descriptions of these insects in the arts. Agrilus, Cryptorhynchus, Anobium, &c [R H L]

Woodcock (*Scolopax rusticola*, Linn) — Although not legally accounted as 'game', the woodcock may not be shot by one who has not a game licence It is more highly prized by sportsmen than any other British bird, except the red grouse, partly on account of its comparative rarity and the uncertainty of its appearance, partly because its rapid irregular flight among trees affords a variety of 'sporting shots', and partly because it is esteemed by many persons as a gastronomic delicacy, although to others the flesh is as distasteful as that of any other exclusively carnivorous animal In general design it is very similar to its near relative the snipe, but the woodcock is much the larger bird, its normal weight being from 11 to 16 oz against the snipe's 4 oz The plumage is admirably protective in its rich mottling of chestnut and black, umber and buff, exactly matching the withered fern and fallen leaves of the woodland Notwithstanding what has been alleged to the contrary, there is no constant distinction in size or plumage between the sexes In habit the bird is strictly nocturnal and crepuscular, as betokened by its large dark eyes It feeds on worms, larvæ, and insects which it extracts from soft or marshy ground, or the droppings of cattle, with its long bill, which is delicately sensitive at the tip Woodcocks pair early in February, the eggs, four in number and blotched with russet on a yellowish ground, are usually laid before the end of March on the bare floor of the wood During incubation, leaves are heaped round the nest by the parent birds, which sometimes carry their young, when hatched, considerable distances to favourable feeding grounds In this process, the nestling is clasped between the thighs of its parent, whose legs are extended to their full length. Although the species is

regularly migrant, woodcocks are to be found in the British Isles at all seasons, those which breed with us and in corresponding latitudes moving southwards in autumn, when they are replaced by immigrant flights from Scandinavia and northern Europe. The birds arriving from oversea are generally much emaciated and feeble; it is a cruel and senseless practice to shoot them in that state; but it is difficult to persuade men to refrain from doing so, for, although woodcocks speedily recover condition and strength of flight, they soon move inland.

It is certain that in former times, before the natural forest had disappeared, woodcocks were far more plentiful in the British Islands than they are now. In the Description of Pembrokeshire, written by George Owen in 1602, it is stated that they were taken in nets 'in cock shoote tyme (as yt is tearmed) w^ch is the twylight . . . yt is no strange thinge to take a hundred or sixe score in one woodd in xxiij houres'.

It is not surprising that such wholesale slaughter should have brought the native stock very low, for it was practised in spring, when the male bird performs a curious flight in the twilight, going and returning repeatedly along the same long course in woodland glades. British law provided no protection for the woodcock previous to 1880, when, in common with other wild birds, it was given a statutory close time from 1st March till 1st August. Previous to that year, in many districts large numbers of woodcocks were shot in March and April, in the belief that these were birds preparing to migrate northwards, whereas in fact they were birds arriving from southern Europe intending to rest in the United Kingdom. Subsequent amending Acts empower County Councils to obtain an extension of close time from the Home Secretary, the Secretary for Scotland, or the Lord Lieutenant of Ireland. In Dumfriesshire and Galloway, for instance, the close time for woodcocks extends from 1st February to 1st October, thus securing protection not only to paring birds in spring, but to immature birds in autumn. The effect of thirty years' close time has been a remarkable increase in the number of woodcocks reared annually in the British Isles, and further increase may be expected in proportion as the woodland area is extended.

The south and west of Ireland has produced larger bags of woodcocks than any other part of the United Kingdom. In the winter of 1863–4 there were shot 1250 cocks at Muckross, in Kilkenny. At Ashford, in Galway, six guns shot 165 cocks in one day in January, 1880, and 365 in four days. But such results can only be obtained where large woods are kept quiet. Woodcocks, being of nocturnal activity, resent having their rest being broken in the daytime. There can be no doubt that the modern system of covert shooting, which requires that the woods shall swarm with noisy, hand-fed pheasants and shall afford two, three, or four great battues in the season, does much to scare away these birds which so greatly court seclusion. [H. M.]

Wooden Tongue. See ACTINOMYCOSIS.

Woodlands, Bookkeeping for.—This should, of course, be reduced to the minimum, as the forester ought to be left free to be in the woods as much as possible. Still, certain books are necessary to be kept for Cash, Daily Labour, and Piece work as regards payments to workmen and others, and a Stock-book, Sales-book, and Ledger for timber transactions. If there be a sawmill under his charge, separate Mill-accounts will also be needed, and for a home nursery a Nursery Stock-book. There is nothing peculiar about a forester's accounts, which follow the simple rules taught in ordinary elementary bookkeeping by single and double entry. What is, however, seldom done, though it is in every instance and from every point of view desirable, is that the forester should each year draw up and submit to the agent or owner, for previous approval and orders, a detailed estimate of income from and expenditure on the woods and plantations. When sanctioned this should form his plan of operations for the coming year and his authority for incurring the charges in carrying out in due season the works therein detailed and approved after proper consideration, so that he does not require to be always referring again to the agent or owner for orders about this or that particular piece of work. And along with such proposals in advance for the coming year, an abstract should also be sent showing the actual income and expenditure of the past year, as compared with the forecast then previously submitted. It is only by having year after year methodical data of this sort, which simplify and facilitate work throughout each year itself and cost no loss of time in unnecessary clerical work, that any landowner, agent, or forester can know what the average gross and the net income from and the expenditure on the woodlands really amount to, or can therefrom estimate with fair accuracy what is the capital value of the woodlands (land and timber-crops) regarded as an income-producing investment. And such data have also a distinct value in framing a simple working plan for the management of the woodlands.

[J. N.]

Woodlands, Extent and Condition of British.—Out of a total land area of 75,520,968 ac. (117,376 sq. miles) for the United Kingdom, only about 3,030,000 ac. (4733 sq. miles) are classified as 'Woods and Plantations'. This gives the low percentage of only 3·9, while the waste lands amount to 21·6 per cent; and it is equal to less than 0·07 of an acre of woodland per head of population. In no other country in Europe is there so small a percentage of woodland as regards either area or population, for even Holland (7·0 per cent, 0·10 ac.), Denmark (5·4 per cent, 0·25 ac.), and Portugal (5·1 per cent, 0·25 ac.), the most poorly wooded countries on the Continent, are better off in this respect. This excessive clearance of the primeval woodlands that once covered the British Isles has, however, been rendered possible by the favourable influence of the Gulf Stream and by the abundant rainfall that can be relied on at all times of the year. The relative distribution of woodlands and wastes is as follows:—

	Woods and Plantations (in thousands of acres)	Mountain and Heath (in thousands of acres).	Percentage— Wood-land.	Waste-land.
England	1665	2306	5·1	7·1
Scotland	879	9375	4·5	48·1
Wales	182	1250	3·8	26·2
Ireland	303	3779	1·5	18·5
Total	3029	16,710	3·9	21·6

Of these woods and plantations 97·7 per cent belong to private landowners, and only 2·3 per cent to the Crown (administered by the Commissioners of Woods, Forests, and Land Revenues of the Crown). There is not a single acre of State forest or woodland in Great Britain, and only a few hundred acres in Ireland recently purchased by the Department of Agriculture, although there has recently been a good deal of talk about State afforestation on a large scale (and especially in Scotland), as recommended in January, 1909, by the Royal Commission on Coast Erosion and Afforestation.

By far the greatest part of our woods and plantations have been formed chiefly for ornament or shelter, although it is as yet impossible to say what total acreage is intended to be worked for profit. From the 15th century onwards the woods in England (including coppices, whether simple or stored with standards for timber) had to be worked on rough lines laid down in Acts of Parliament (see Arboriculture and Arboriculture, Statutes Relating to), though these provisions were often habitually evaded. But down to about a hundred years ago the copsewoods on land unsuitable for agriculture were often the most profitable parts of an English estate, and were let along with the farms, the coppice underwood being cut in regular rotation by the tenant, and the timber overwood by the owner. The oldest classes of standards of Oak and Elm, &c., still found in copses date from the time when there was a large demand for home-grown timber for shipbuilding, &c. But during the 19th century the increasing supplies of then cheap foreign timber gradually undercut the prices for home-grown wood; and when in 1867 the small import duty on foreign timber was removed, a slump took place in the price of home wood, from which a recovery is now only becoming apparent owing to shrinkage in the world's timber supply and increase in its demand. But the immediate effect in 1867 was to limit greatly the sale of home-grown timber at profitable prices; and the result was that many woods, previously worked for profit on more or less systematic lines, were thrown out of anything like regular management and became game coverts or were retained chiefly for ornament. But even such woods and plantations as have been continuously managed with a view to profit mostly show, in their present condition, the effects of the overthinning which was customary as a result of growing Oak trees in comparative isolation with a free growing-space, for the production of strong limbs and crooked branches desired for shipbuilding. Under this method, originally enforced by Acts of Parliament, it was customary to regard as necessary such an amount of thinning as would give a distance from stem to stem equal to about one-third of the height of the trees, without any regard being had to the demand of any given kind of tree for light or its capacity for bearing shade. Thus woods of Larch or Pine of 60 ft. high would be thinned till the trees stood 20 ft. apart, and the same rule of thumb was also applied to Spruce or Silver Fir, notwithstanding the fact that they are shade-enduring species not needing a large growing-space, and that the danger of windfall must always be very greatly increased by such unnecessary and irrational overthinning. Hence most of our British woodlands are comparatively open, and consequently often carry less, and seldom more, than from two thirds to three-quarters of the timber per acre that they might be bearing. Also, by keeping the woods close, the tallest, straightest, and cleanest boles are produced, and this class of timber is now usually much more easily and profitably saleable than the rough and crooked timber formerly wanted. One effect of heavy thinning, however, must at the same time be noted: it certainly brings about at an earlier age than would otherwise be the case the culmination of both the current annual and the average annual rate of growth. This would of itself be, of course, of advantage to the timber grower, both as involving less capital and as giving earlier returns, unless (as must usually be expected) the shape, quality, and value of the timber be thereby affected. If plantations be made for the special purpose of growing pitwood with a rotation of 30 to 40 years, however, this method of heavy thinning might quite probably be shown to be sometimes the most profitable system to adopt. But generally throughout Britain the present thin and unsatisfactory condition of the woods and plantations is mainly due to the erroneous notions that have until very recent years obtained with regard to thinning. This is now better understood than formerly; and when timber crops now maturing are cleared and replanted, thicker and more profitable woodlands will probably take their place. See also Forests [J. S.]

Woodlands—Management, Protection, and Utilization of.—Woodland Management.—As in every other commercial enterprise, capital is required for the production of timber, and profit is not likely to be earned unless careful management be adopted. But this is rendered more difficult from the fact that the capital employed, consisting partly in land and partly in timber, is (as also in banking) of precisely the same nature as the product. Hence the annual falls must be so regulated as to enable the proprietor to harvest the largest possible annual increment, while duly preserving the proper amount of a growing stock of timber of all ages required for the total woodland area. In highwoods worked with a long rotation the capital in wood far exceeds the value of the land, whereas in copsewoods there is less difference in the amount of each part of the capital. But in order to distinguish care-

fully between capital and increment in high-woods, a stock-taking should be made every ten years or so. Where the woodland area is small, working may have to be intermittent; but in extensive woodlands the aim should be to assure regular supplies of mature timber and thinnings of about equal amount annually, so as to provide a regularly sustained yield. To secure this, the woods must consist of a regular series of crops varying from each other either by one year only (as in annual falls of Pine, Larch, &c.), or else by such a number of years that strips may be grouped together in periodic falls for natural regeneration (as in Beech, Silver Fir, &c.) The series of falls need not succeed each other contiguously like one long arithmetical progression, but they must all be included in the area under management (*working circle*), otherwise a regularly sustained yield is impossible A perfect adjustment of capital and product is unattainable, but the aim and object of any sound scheme of management (*working plan*) for woodlands intended to be worked on purely business principles is to try and bring the woods as near as possible into an ideal state or *normal condition*, which would consist in—(1) a *normal succession of crops* of all ages from seedling up to mature tree, each age-class occupying an equal or equally productive area, (2) a *normal density* or full stock throughout each such area; (3) a *normal increment* or rate of growth in each crop fully proportionate to the quality of the soil, and (4) a *normal distribution of the annual falls* arranged in the most advantageous manner. Given these four ideal conditions, the results secured would be—(1) a *normal growing-stock* or capital in wood, with a regular series of annual or periodic falls distributed over the working circle, and (2) a *normal increment* or annual production of wood proportionate to the quality of the soil and the climate. The nearer the actual condition of woodlands approaches to this ideal normal condition, the greater are the advantages secured by having a regular annual supply of timber to meet local demand and a regular income from its sale, cheaper and more efficient labour through employment being more regular, and less danger from windfall, insects, fungus diseases, &c.; while the only drawbacks are that in trying to attain the normal condition some crops may have to be cut before being fully mature, and others may have to stand for some years after they have already begun to sink in rate of growth.

The normal capital in wood needed in timber-growing may be roughly estimated as equal to ½ (annual fall × number of years in the rotation), the annual fall being the number of acres felled multiplied by the yield per acre in cubic feet; and each annual fall removes the normal yield throughout the whole woodland area, in the shape of the complete growth of each successive year throughout the whole period of rotation, which is actually stored up in the mature trees felled. Say, for example, that a simple coppice is worked with a rotation of 10 years; then in spring (just after a fall) the crops on the ground will respectively be 0, 1, 2 . . . 7, 8, 9 years old, and in autumn (just before a fall) 1, 2, 3 . . . 8, 9, 10, and the average of these two series, taken in summer, will give ½, 1½, 2½ . . . 7½, 8½, 9½; while the sum of all the 10 factors in this arithmetical progression will be $\left(10 \times \frac{10}{2}\right)$; and this in the case under consideration means the produce per acre obtained at 10 years of age, multiplied by half the number of years (10) in the rotation And it is the same with high-wood crops worked with a rotation of 60 to 100 years or more, whether they be treated by annual clear fellings, or by several annual falls being grouped to form a periodic fall for purposes of natural regeneration

These are the fundamental theoretical principles upon which woodland management is based; and their application consists in first of all subdividing the total area into convenient blocks and compartments, forming the permanent framework for future administration, and then (if necessary) forming working circles (for simple coppice, copse with standards, broad-leaved high-woods, and conifer high-woods) each containing the whole of the regular series of annual or periodic falls for the areas, subject to the same details of treatment. Hitherto these principles have been to a great extent disregarded in Britain, but they will need attention if any great national scheme of afforestation be undertaken. A register has then to be drawn up of all the woodlands, to arrange them in their several periodic age-classes (0–20, 20–40 years, &c.) and see how this corresponds to a normal age-class distribution, and also to consider which of them should come to the fall within the next 10 years or so—average sample plots being carefully selected and measured where it is desirable to ascertain the quantity of timber and the current annual increment throughout these maturing or perhaps overmature parts of the woodlands When field work of this description is completed, a tabular working-plan can be drawn up for the next 10, 15, or 20 years, indicating how the wishes of the proprietor can probably best be attained, and by a revision of this every 10 years or so, a sound scheme of management can be gradually introduced with regard to felling, thinning, natural regeneration or planting, &c

The Valuation of Woodlands takes place by means of formulæ based upon the general formula for summarizing a geometrical progression, as all summarizing or discounting of money invested in or derived from woodland operations has to be dealt with strictly by compound interest In such calculations it is best to take 3 per cent as the usual rate of interest, for arbitrary raising or lowering of the percentage may easily lead to calculating results always very divergent, and often contrary to common sense. The capital in woodlands (land and growing-stock) may be valued by four different methods, by estimating (1) the actual cost of production (so far as concerns the timber crops), (2) the market value if sold or compared with similar adjoining properties, (3) the prospective value as to future net income, or (4) the capitalized value estimated on the average net income (where $C = 100 \times$ net annual income at p per cent) This last method is that adopted in valuation for succession duty, but a sliding scale

diminishes the capital value according to the age of the incoming life-tenant In all cases of woodland valuation only net income should be taken into calculation. And to estimate the true returns from woodland crops as to thinnings at different times, as well as the mature fall, the age at which each thinning is made must be noted, and the net income therefrom must be capitalized to the time at which the mature fall is made.

Woodland Protection is that branch of forestry which treats of the prevention of and remedy for damage of any sort, whether directly or indirectly due to human actions, farm live-stock, game, rodents, birds, insects, fungus diseases, weeds, wind, frost, or any other cause.

1 *With regard to human actions*, in all countries possessing extensive forests special forest laws have been found necessary to afford adequate protection but in the United Kingdom, with its paucity of woodlands and almost entire absence of State forests, the only legal protection given to woods and plantations or to trees and shrubs is that provided by the ordinary criminal and civil law (see Arboriculture, Statutes Relating to) This covers damage by theft, malicious injury, erection and maintenance of boundary marks, regulation of commonage and rights of user, trespass, carelessness, and fires (which frequently prove the most serious of all: see Fires in Woodlands)

2. *With regard to farm live-stock*, the only suitable method of securing protection against damage by horses, cattle, or sheep is to enclose and fence the young plantations for at least 10 or 12 years in much the same manner as against deer and ground game (see Fence Posts and Fences) This is a precautionary measure adding to the original cost of a plantation for though the owner is not bound to fence, he must abide by the consequences of not doing so, although a civil action might be against any neighbouring proprietor whose cattle strayed or trespassed into and damaged the plantation, but if a plantation immediately adjoining a highway remains unfenced, the owner cannot complain if cattle stray on to it from the highway, and must bear any loss caused thereby In countries like France, Germany, Italy, India, &c., where woodland grazing is of importance, the action of proprietors and of graziers is usually limited by rules framed under Forest Acts and having the force of law, concerning such matters as the closing of falls bearing young crops, adequate supervision, prohibition of grazing during the night, or of driving herds into the woods too soon in spring, &c.

3 *With regard to game*, the damage may vary greatly, both as to its nature and its extent, according to the class of game; and the same may be said as regards the best method of affording the protection necessary in each case (see Game—Damage to Woodlands). But although red deer and roedeer (see Red Deer and Roedeer), and hares and rabbits (see Hares and Rabbits) may be kept out by fencing and wire-netting (at an outlay which adds considerably to the prime cost of the plantation, though it should properly be debited to the game account), yet there is no possible protection against blackcock, except constant endeavours to keep down their numbers by shooting them during the open season. As blackcock (*Tetrao tetrix*) increases rapidly among the long grasses and other weeds which spring up strongly when poor grazing tracts are enclosed and planted, they constitute one of the great dangers to which young conifer plantations (and especially of Larch and Silver Fir) are now exposed in the Highlands of Scotland.

4 *With regard to the smaller rodents*, woodlands have to be protected against squirrels, mice, and voles, which all do considerable damage when allowed to increase in large numbers (see Squirrels and Mice and Voles) Throughout the north of Scotland the damage done by squirrels gnawing the bark of young polewoods and older woods of Pine and Larch was so great that 'squirrel-clubs' had recently to be formed in Ross-shire and the adjoining counties, and by paying threepence a tail for several thousands of squirrels, their numbers have now become greatly reduced. But constant shooting (especially during nesting time) is needed to keep this destructive, though pretty, little animal in check Mice and voles can best be kept down by protecting their natural enemies among birds and other animals, such as owl buzzards, kestrels, weasels, hedgehogs, foxes, &c; but when they increase in large numbers and become a plague (as in Perthshire in 1863, and in the south-west of Scotland in 1892), one of the best ways of getting rid of them is by poisoning with phosphorus paste added to oatmeal laid in drain pipes scattered throughout plantations.

5 *With regard to birds*, next to the game birds blackcock, ptarmigan, and capercailzie, the most destructive kinds are the wood pigeons among the Columbidæ, the common jay and the nutcracker among the Corvidæ, the chaffinch, the mountain finch, and the hawfinch among the Fringillidæ, and the common crossbill (Loxia). These can only be kept down by shooting when they begin to become troublesome, and especially as regards wood pigeons, the interests of the farmer and the forester are in this respect identical, for they are very destructive to acorns, beech mast, &c., when swarming in large flights. Fortunately, however, most birds, and especially the song birds, are insectivorous, and therefore useful in keeping down insects Starling, cuckoo, tits, swallows, flycatchers, wrens, &c., are all thus useful, while owls (except the great owl) and the black-headed gull also help to keep down mice and voles. Birds that are on the whole more useful than destructive include lapwing, plover, bullfinch, goldfinch, greenfinch, woodpeckers, thrushes and blackbirds as regards insects, and crows, rooks, and jackdaws, buzzards and kestrels as regards mice and voles The best mode of increasing the number of useful birds, and thus protecting the woodlands, is to erect nesting boxes high up on trees.

6. *With regard to insects*, the best general protective measures are careful cleaning and weeding of young plantations, and thinning and tending of all older woods; mixing the different kinds of trees in groups according to the different

kinds of soil and situation; removing quickly all dead stems or branches and the debris left after thinning or felling, and rectifying damage done by natural agencies, while the special protective measures include also peeling the bark of all trees, and especially coniferous timber, which have to remain for some time in the woods after felling (though a few unbarked logs may be left here and there temporarily to act as decoy-stems for bark beetles, to be removed and barked after

Fig 1 —Grubbing Stump with 'Monkey' Jack

the eggs are laid, but before they are hatched out), grubbing up stumps, wherever a good market for firewood makes this practicable, and taking measures to increase the number of insectivorous birds and of parasitic insects (Ichneumonidæ, Braconidæ, &c) which prey upon the destructive kinds

7. *Protection against weeds* is only obtainable by soil preparation previous to planting, and by careful cleaning and weeding till the young plantation establishes itself (see Plantations, Cleaning of).

8 *Protection against fungus diseases*, often very destructive in conifer woods and plantations, can best be obtained by carefully carrying out the general protective measures indicated above for insects, though special diseases require special measures (see Fungi)

9 *Protection against injuries due to inorganic causes or injurious influences in soil or atmosphere* may vary greatly according to the nature of the inducing cause, and the special measures which experience shows to be most useful will be found indicated in the various articles on Frost, Heat, Lightning, Wind, &c.

Utilization of Woodland Produce is one of the four main branches of instruction in modern forestry, its object being to instruct those engaged in growing timber and minor produce in all that affects the technical qualities and uses of the raw material they bring to market, and thus enable them to supply, so far as possible, the special demands as to kind, quality, and most suitable dimensions and assortments. The technical properties, practical uses, and market value of timber depend to a great extent upon the anatomical structure and the chemical composition of the different kinds of wood (see Timber); and of course, a large demand being constant, the market value is proportionate to the quality for any specific purpose. The prices obtainable for timber vary greatly in different localities, while its value in the woods depends on its distance from the sawmill or the place of consumption. Its value *in situ* may be estimated by deducting the cost of transport, and about 15 to 20 per cent for the timber merchant's profit, from its market value at the place of sale; and of course this shows the importance of good roads and easy lines of transport In 1908 the average value of some of the chief kinds of British timber in the woods was per cubic foot—Norway Spruce, 3*d*. to 6*d*; Scots Pine, 4*d* to 6*d*, Birch and Alder, 6*d*, Ash and Larch, 10*d* to 1*s*. Beech, 1*s* 1*d*; Oak, 10*d*. to 2*s* 6*d*.

Woodlands allow of thinnings every 5 to 10 years before maturing to give their final yield in timber, and they also give minor produce in the shape of tree seeds, resin, tanning bark, &c, before or at the time of the cutting of coppice and the felling of standard trees and highwoods Coppices and small thinnings are cut with hand bills or billhooks, while axes and saws are used for felling timber, and when stumps are removed they have to be extracted by jacks and other machines giving strong leverage, such as the Hawk-eye (horse power) and the Australian Monkey-jack (screw power) The most effective bills for coppicing are those that are well balanced and fairly heavy, and the best stroke can be given when the pole is bent slightly down with the left hand, so as to give a clean, smooth cut as near the ground as possible (see also Coppices and Osiers) In felling large poles and mature trees the use of axe and saw is general, and the best season is autumn and winter, when there is least sap (see Felling of Timber)

Fig 2 —Grubbing Stump with onkey' Jack

Felled timber should be removed from the woods as soon as possible, and conifers in particular are almost certain to become infested with bark beetles if left on the falls after May, unless the logs are peeled. If timber has to be stored in depots before conversion, it should be raised well off the ground, and conifer logs should also be barked. The cost of cutting and sorting 12- to 16-year-old coppices varies from about 10*s*. to 15*s*. per acre, according to thickness of crop; while the cost of felling, trim-

ming, and logging timber is about 1*s.* 6*d.* to 2*s.* 6*d* per load of 50 cu. ft. for conifers and softwoods, 2*s.* to 3*s.* for most hardwoods, and 2*s.* 6*d.* to 3*s.* 6*d.* for Oak and Ash. The marking with serial numbers of trees and logs or lots of timber can best be done with a revolving numbering hammer (Gohler's).

Coppices are usually sold standing, either privately or by auction, at so much per rood or acre, to be cleared by a fixed date (end of March for ordinary coppice, middle or end of May for oak bark coppices), the poles to be reserved as stores or standards being marked with a ring of whitewash or paint about 5 ft up Oak bark coppice, once very profitable, hardly pays now, and most of the coppices of this kind have been or are now being converted into highwoods (see BARKING), while hurdle-making is now also almost a lost art

In Britain timber is sold by public auction, by tender, or by private contract, and it may be sold either standing or felled Where practicable, it is usually best to sell it standing, at fixed rates for first- and second-class dimensions (also to be fixed), with a reasonable deduction in case of unsoundness (see TIMBER MEASUREMENT) Felling of timber sold standing may either be done by the seller or the buyer, but the proprietor's own men are more likely to be careful of his interests with regard to damage to fences, other trees, underwoods, &c., such as often gives rise to disputes If timber be felled before selling, the landowner (unless he has a sawmill) is sooner or later forced to sell, even if he does not get a fair price for it; and in any case he is practically defrauded of part of the value of the timber where rings are formed to keep down the selling price locally, and then to hold a 'knock out' sale among the timber merchants themselves In whatever manner timber be sold, the conditions of sale should include stipulations regarding mode and time of payment, and mode, time, and route of extraction, and also provision in case of the buyer failing to satisfy all his covenants.

In Britain the transport of timber from the woods to the sawmill or railway, &c., is mostly by horse and cart or wagon, both the four-wheeled timber cart and the two-wheeled janker or 'timber bob' with broad-flanged wheels being largely used for this purpose But traction engines are also used for heavy road traffic, and on some estates (*e.g.* Canonbie in Dumfriesshire, and Bowmont in Roxburghshire) portable tramways are employed. Here dragging is mostly done by horses, but on the Continent oxen are largely used. Dragging of heavy logs can be facilitated by the use of a dragging shoe, and by raising the ends on little sledges, and the sledging of poles and logs might with profit be far more largely adopted in hilly woodlands than is yet the case in Britain. The cost of carting varies greatly according to kind of wood, distance, gradient of road, state of weather, &c., but is usually about 1*d.* to 1½*d.* per cu. ft. per mile up to 4 to 6 miles, and ½*d.* a cu. ft. per mile beyond that. Carting is generally cheaper wherever there is a good network of metalled roads; while tramways (best gauge 24 in.) are only cheaper when the land is level or slightly downhill and the gradient slight; but the use of a traction engine and goods wagons is economical when long distances have to be covered, and especially if conversion can take place at a sawmill in or near the woods before transport Railway transport is in Britain regulated by the general railway classification of goods, which prescribes the method of measurement and classifies the rates payable for different kinds of timber Transport on inland waters can take place by loose-drifting or floating in rafts Floating is customary in Strathspey, but many of our inland waterways might be much more utilized thus, as all of our conifers and most of our broad-leaved trees are floatable, and water transport is cheapest

The durability of timber can be greatly increased by proper seasoning (see SEASONING OF TIMBER) and by impregnating it with antiseptic and therefore preservative substances (see TIMBER PRESERVATION), among which creosote and napthalin are chiefly used in Britain.

The utilization branch of forestry also includes instruction concerning woodland industries, such as estate sawmills, preparation of wood pulp and cellulose (see CELLULOSE), the burning of charcoal (see CHARCOAL), resin-tapping and the preparation of turpentine and rosin, preparation of potashes and acetate of lime, the profitable use of sawdust and small waste wood (see SAWDUST), and grazing in woodlands, which are often profitable in extensive forests, and more especially when these are located at a considerable distance from large wood-consuming centres [J. S.]

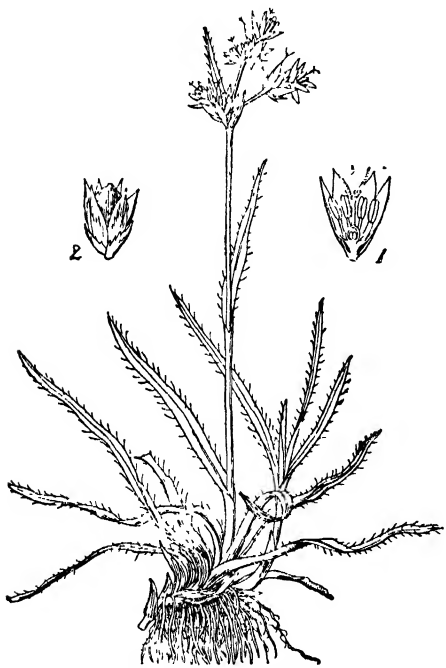
Woodlands, Valuation of. See art. WOODLANDS MANAGEMENT, PROTECTION, AND UTILIZATION OF

Woodlouse, commonly called the 'slater', frequently causes serious damage in hothouses. See arts. ONISCUS, ARMADILLIDIUM

Wood Pigeon, or the Ring-dove (*Columba palumbus*), is the largest and commonest of the four British species of pigeon It is well-known in every part of Great Britain, but is much more numerous in the east than in the west Its depredations are so great as to cause severe loss to agriculturists in many parts of England, and its suppression has become a matter of some urgency. Its food consists of seeds and grain of all kinds, peas, berries, turnips, &c In the country generally, its extreme shyness makes it very difficult to approach and secures it comparative safety; but in the London parks, where it has now for many years successfully established itself, it has become so tame as sometimes to feed out of the hand The Ring dove is found during the warm weather throughout the wooded districts of Europe, and in North Africa; while in the colder seasons it deserts the more northerly regions, and its numbers are proportionately increased in the south In the winter it goes about in large flocks, but in summer it is usually seen in pairs The nest is of very flimsy construction, consisting of a few twigs laid crosswise on a tree. In it are deposited two, or occasionally three, white eggs. Two or three broods are produced in the year. The Ring-dove derives its name from the patches of white

on each side of its neck. In flight it is easily recognized by two conspicuous white bars across the wings. [H S R. E]

Woodrush, or **Field Woodrush** (*Luzula campestris*), is a perennial creeping herb belonging to the nat ord Juncaceæ Unlike its relation the true Rush (Juncus), this species prefers dry land, and in poor, dry, sandy and heathy pastures often accompanies such grasses as Sweet Vernal. Scanty tufts of the foliage (readily grazed by sheep) appear on the ground in early spring, when, with its flat leaf-blades, the



Woodrush (*Luzula campestris*)

1, Vertical section of flower. 2, Fruit.

Woodrush is often mistaken for grass. Such confusion is, however, impossible when we observe that the leaf-blades are arranged in several (not in two) rows, and that the margin of each blade bears a conspicuous fringe of long white hairs. In April or May, leafy stems, often only 3 or 4 in high, grow out from the tuft of foliage These terminate in branches clothed with compact clusters of minute dark-hued flowers, which ripen and form one-chambered capsule fruits, each containing three seeds Thus Woodrush can not only propagate from the creeping underground stem, but can also spread freely by seeds The simplest plan for keeping it down is to foster luxuriant growth of the associated grasses by topdressing with suitable manures.

Several species of Woodrush are tall shade plants often abundant in woods on sandy soils, *e.g.* Great Woodrush (*Luzula sylvatica*), with leaves often several feet long, capable of retaining their verdure throughout the winter [A. N. M'A.]

Wood Sorrel (*Oxalis Acetosella*), sometimes called Shamrock, is a perennial herbaceous shade plant belonging to the nat ord. Oxalidaceæ It is common in woods in Britain, throughout Europe, in Central Asia, and in North America. Underground, there is a horizontal stem (creeping rootstock) covered with scales (persistent bases of leaves) From the growing apex of this stem a tuft of leaves springs up, with a characteristic leaf-blade divided into three leaflets radiating from the apex of the leaf-stalk. The leaflet when chewed has an acid flavour, due to the presence of acid oxalate of potash Along with the leaves there appear in early spring solitary white flowers veined with purple, which when ripe form chambered capsules, each chamber containing two glossy-black seeds [A N M'A]

Wood Wasps. See arts Sirex

Wool.—The woolly covering of the sheep forms the most important raw material employed in the manufacture of textile fabrics that are used for clothing in which warmth is a desired feature It also enters largely into the composition of other textures than clothing fabrics, as, for instance, carpets, tapestries, and upholstery cloths Wool is a modification of hair, it grows in the same manner, and is similar in chemical composition In physical structure, however, it is materially different from hair, and it is to this difference that the material owes its great value as a textile fibre. Commercially, the produce of the Angora, Tibetan, and certain South American goats, and of the camel, which more nearly approaches the structure of hair, is classed as wool, but the supply of these fibres is very much less than the supply of wool. In its natural condition the sheep grows both wool and hair, but in the domestic animal, consistent care and cultivation during succeeding generations, together with careful selection in breeding, have so improved the character of the covering that in the best fleeces the hairs are entirely absent or are of infrequent occurrence Under unfavourable conditions, however, such as continued exposure to inclement weather, sheep always tend to grow hairlike fibres (termed 'kemps') mixed with the wool.

The Growth of Wool.—Wool grows from a hair-follicle or gland situated in the middle layer of the skin The gland secretes a lymphlike liquid from which, by the process of growth, the fibre is gradually developed, being composed ultimately of cells of different forms and properties The gland secretes also, and supplies to the fibre, an oil which, acting as a lubricant, makes the wool flexible; this oil forms a true constituent of the fibre In addition, a fatty substance, known as 'wool grease' or 'wool yolk', is poured on to the fibre before it reaches the surface of the skin by the sebaceous glands The wool grease covers the surface of the fibre, and serves to protect it from mechanical injury during its growth, and at the same time prevents the fibres from becoming

matted or felted together on the sheep's body The sweat from the animal—termed *suint*—and extraneous matter such as earth, sand, seeds, and particles of vegetable matter, also adhere to the fibres. Before the wool can be used for textile purposes the fatty covering, the sweat, and the other impurities have to be removed, but it is necessary for the natural oil to be retained in the fibre or the wool will lose much of its pliable and resilient nature

Structure of Wool.—The wool fibre, when observed under a microscope in the clean condition, has the appearance of a solid rod covered on the surface with irregularly shaped scales which project from the root to the tip of the fibre, and overlap each other like the scales of a fish or the tiles of a roof. Generally the fibre is cylindrical in cross section, but in some cases the form is elliptical It is built up of a vast number of individual cells, which are in three

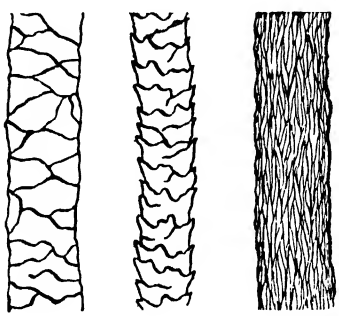


Fig 1

series (*a*) An outer or epithelial layer of flat cells which form thin, broad, irregularly shaped, horny scales covering the entire surface of the fibre and projecting from the root to the tip In some wools each cell appears to completely surround a fibre, but in most cases longitudinal striations are observable The rear edge of each scale is securely embedded in the fibre, the forward edge, where it overlaps the preceding scale, may lie flat to the surface, or protrude more or less freely from the body of the fibre. The former condition is commonly found in coarse wools, and the latter in the finer varieties The presence of the scales, and the direction in which they point, can be detected by holding a single clean fibre between the finger and thumb of each hand, and drawing the hands gently apart; the end nearest the tip of the fibre readily slips, whereas the root end remains stationary. The form of the outer scales affects the lustre and the shrinking or 'felting' property of the wool, if the scales are comparatively large, and lie flat to the surface of the fibre, as represented at A in fig 1, the wool is lustrous; but, on the other hand, if they are small, and have free protruding edges, as shown at B in fig. 1, the wool is dull in appearance, but is generally a good felting wool. The number of surface scales per inch varies from about 2000 in the fine merino wools to about 1400 in the long English wools.

(*b*) The cortical substance within the outer scales, which forms the bulk of the fibre, consists of narrow cells each of which tapers to a point at the ends These cells dovetail with each other in the manner represented at C in fig 1, and form a dense, compact, elastic structure which, on account of the cellular formation, absorbs moisture very readily. This is an important feature to the dyer, as it gives the material a strong affinity for colouring matters

(*c*) The centre of the fibre consists of medullary cells, which are rounded and generally larger than the surrounding cortical cells These cells may be in a single series, or in several series arranged side by side; in some cases they form a continuous line in the fibre, but in others they occur only at intervals The medulla provides an internal channel for the flow of the lymph which nourishes the fibre during its growth There is no sharp line of division between the three parts of a fibre, and in the fine varieties of wool the presence of the medulla frequently cannot be detected, but it is generally observable in coarse wools and in the wool hairs In wools that are naturally black or coloured, the matter to which the fibre owes its colour is chiefly situated as a granular pigment between the medullary cells; in some coloured wools the colouring matter also permeates the cortical cells

Chemical Composition of Wool.—The fibre is gelatinous, and in the clean condition is composed of carbon, hydrogen, oxygen, nitrogen, and sulphur These elements, however, are not present in constant proportions, hence a definite chemical formula cannot be assigned to wool It is similar in composition to horn, whalebone, feathers, &c, consisting of a substance to which the term 'keratine' is applied, the average percentage of wool keratine is carbon 51, hydrogen 7, oxygen 21, nitrogen 17, and sulphur 4. Sulphur is the most variable constituent, and is found to range from $2\frac{1}{2}$ to 5 per cent, its presence in certain circumstances is a disadvantage in dyeing, because when lead is present in the dye solution the sulphur in the wool combines with the lead and forms sulphide of lead, which makes the colour appear duller When wool is burned an ash is left, amounting to about $\frac{1}{2}$ per cent, which consists chiefly of phosphates of lime and magnesia, and sulphate and carbonate of lime

Action of Chemical Substances on Wool.—Strong alkalis, such as caustic soda and caustic potash, have a most injurious effect upon the fibres at any temperature, and even a dilute solution (from 2 to 4 per cent) at boiling temperature will dissolve wool The carbonates of soda and potash, if strong and at high temperatures, will also destroy the fibres; but in weak solutions and at moderate temperatures they are not injurious, and are largely used along with soap in scouring wool Mild alkalis such as borax, phosphate of soda, and ammonia, in weak solutions, are also uninjurious Dilute nitric acid, when boiling, tends to turn wool permanently yellow, this acid is frequently used

to strip the colour off shoddy—that is made from dyed rags -in order that the material may be re-dyed. Hot, concentrated, hydrochloric and sulphuric acids will destroy wool, but in dilute solutions (not exceeding 3 per cent of acid) these acids, even at high temperatures, have very little effect on the fibres further than opening out the surface scales and thereby making the material harsher to the handle Sulphuric acid, however, has a very destructive action upon vegetable matter, and frequently advantage is taken of this in removing vegetable matter when there is a large quantity present in the wool.

Physical Properties of Wool.—The qualities or properties in wool which influence its value and suitability for different purposes, and by which it is judged, are. strength and elasticity, trueness of fibre, fineness, softness and flexibility, curliness or waviness, length and uniformity of staple, lustre; felting property, hygroscopicity, affinity for colouring matters, natural colour, freedom from vegetable impurities and kemps, and quantity of wool yolk.

Strength and Elasticity —Wools vary greatly in tensile strength and elasticity according to the breed of the sheep, the quality of the wool, and the diameter of the fibre A coarse fibre is stronger than a fine fibre, but in proportion to its thickness the latter is generally stronger than the former The peculiar cellular arrangement renders the structure very firm, flexible, and elastic, a fibre can be bent or turned any way without injury, and when subjected to pressure the cells offer resistance so that when the pressure is removed the material returns to its former condition The degree of elasticity may be noted by gradually stretching out a fibre until it breaks if the elasticity is good the two ends shrink and twist up, but if deficient in elasticity they do not alter much in position. Both strength and elasticity are very important in spinning and weaving, and in the felting process, in enabling the fibres to stand the strain to which they are subjected

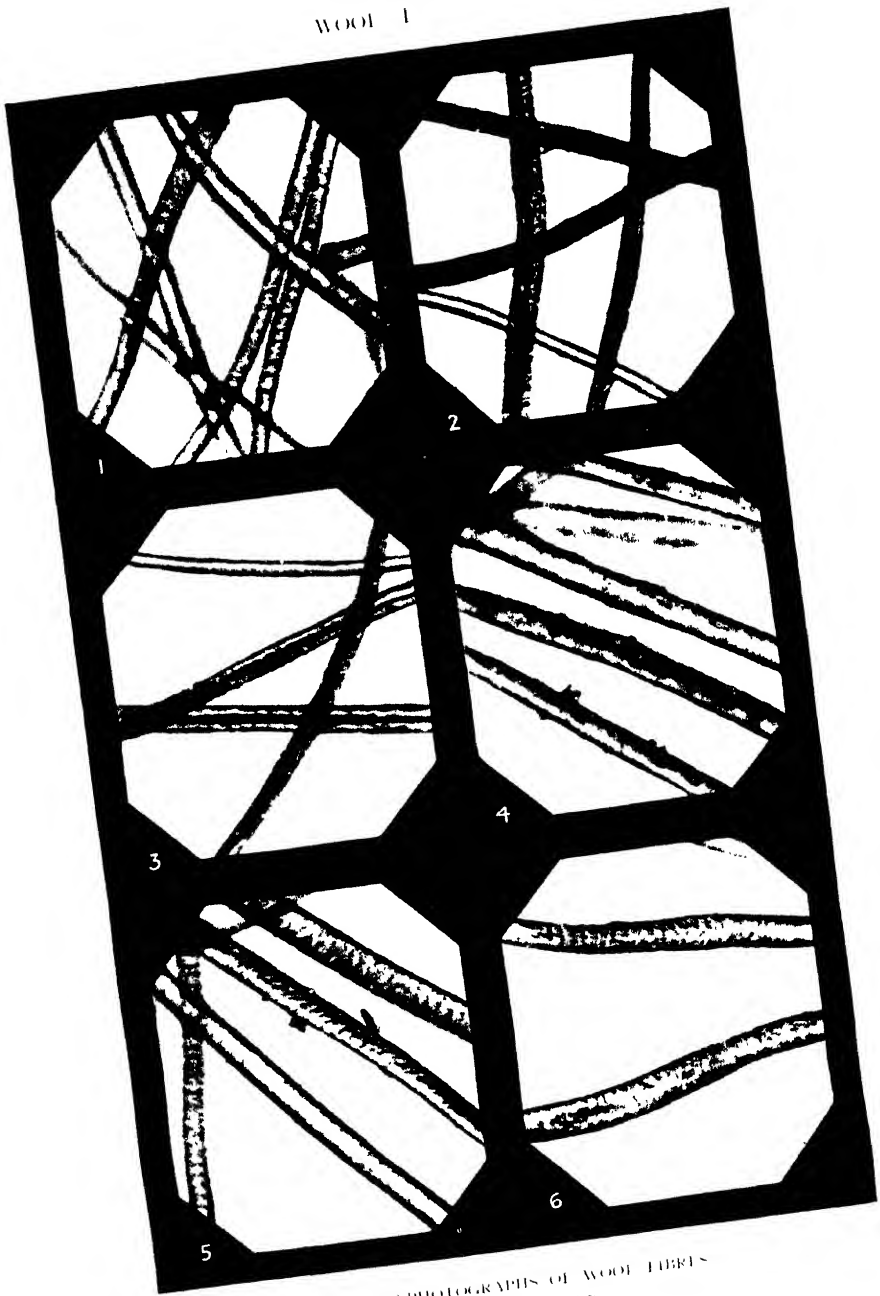
Trueness of Fibre - Uniformity in strength throughout the length of the fibres is of great importance to the spinner, because if they contain weak or tender places they are liable to break at these positions This results in a decrease in the average length of the wool, while the short broken ends of the fibres will, in combing, be taken out as waste Tender wool is grown during the period that a sheep is in bad health, or is suffering from want of proper nourishment, or from cold, on the return of normal conditions the fibres regain their strength, but the tender part in the fleece reduces the value of the wool for any purpose, and may render it quite unsuitable for certain uses.

Fineness.—Fibres vary in fineness to a considerable extent, not only in different breeds, but also in the same fleece It is necessary, however, to consider fineness in relation to length, because, as a rule, fineness is proportionate to length If other properties of wool are equal, the finer the fibre is, the better it is for textile purposes, because for a given size of thread more fibres are required if they are fine than if they are coarse. A greater number of fibres makes the thread fuller, and the cloth has a superior appearance and handle Also a finer thread can be spun from a wool that is superior in fineness Merino wools vary in diameter of fibre from $\frac{1}{1500}$ in. to $\frac{1}{3000}$ in., although the latter is exceptional, Southdown wools range from $\frac{1}{1000}$ in to $\frac{1}{1500}$ in in diameter; while in the long lustrous wool the diameter varies from $\frac{1}{500}$ in. to $\frac{1}{800}$ in.

Softness and Flexibility —These properties, to a large degree, vary according to the quality of the wool, fineness, softness, and flexibility almost invariably go together, and it is generally found that wool from a pure breed is softer and more flexible than cross-bred wool. The nature of the outer scales largely influences the pliability of wool, if the edges of the scales are free the wool is soft and yielding, whereas if the scales fit closely to the surface, the fibres are stiffer and are not so easily twisted together in the thread For very many purposes wool of a soft pliable nature is essential, and the softer it is the greater is its value, but in some cases—*e.g* Scotch tweeds, in which crispness of handle is a distinguishing feature—wool with a somewhat harsh handle is more suitable than a very soft wool.

Curliness or Waviness —In short, fine wools the fibres have a characteristic twisted or curly form, the number of curls per inch ranging from 18 to 30 according to quality The number of curls appears to vary in relation to the fineness of the fibre, thus in medium wools the number varies from 10 to 18 per inch, while in the coarse lustrous wools the formation is more of a wavy than a curly character, Lincoln wool having from 3 to 5 waves per inch, and mohair 1 or 2. The curly formation appears to be due to unequal contraction of the surface of the fibre- caused by irregularity in the growth and arrangement of the cortical cells, and uneven drying of the fibre If wool is immersed in hot water and then dried in a stretched condition the curliness is removed, but if again wetted and allowed to dry without tension it regains its curly form The curliness adds to the spinning quality of the wool, because the fibres adhere to each other more readily in the thread, it enhances the elasticity and springiness of the material into which the wool is made, and in the felting of wool it assists in the interlocking of the scales

Length and Uniformity of Staple -- Wool grows in the form of staples or bunches of fibres in which each fibre has the same degree of curliness or waviness, the latter property thus appearing to have some influence in producing the staple formation The staples in a fleece are readily separated from each other, whereas the individual fibres in a staple are only separated with difficulty when the grease is present. The stapled arrangement prevents water from penetrating the wool during its growth, and by holding the fibres together protects them from injury Uniformity in length of the individual fibres in the staples is important, 'tippy' wool, in which the staples taper rapidly to a tip or



MICROPHOTOGRAPHS OF WOOL FIBRES

Enlargement: diameters

1 New Zealand Cross-bred ... 2 Kent Lamb ... 3 Late Kent Lamb
4 Cross-bred Home ... 5 Blue Hair ... 6 Fine Cross-bred Home

point, is wasteful for combing purposes, because it contains a large proportion of short fibre and only a small proportion of long fibre. The length of staple, by which is meant the average length of fibre in a specimen, varies exceedingly in different breeds, and frequently in the same fleece. It ranges from 1 to 4 in. in fine merino wool to from 8 to 15 in. and upwards in long lustrous wools, while between the extremes all degrees of length are produced by the different pure breeds and crossbreeds. If other conditions are equal, the longer wool is, the better are its spinning qualities, and the stronger the resultant thread; also the thread is cheaper to produce, because less twist is required in giving the necessary cohesion to the fibres.

Lustre.—This property varies according to the manner in which the light is reflected from the surface of the fibre, and is therefore chiefly dependent upon the form of the outer scales. The long Lincoln and Leicester wools and mohair and alpaca are comparatively thick in the fibre with large scales lying flat to the surface, which, being smooth, reflects the light directly to the eye of the observer, hence the lustre is developed in the highest degree in these wools. On the other hand, short merino wools have a fine fibre, curly form, and small scales with protruding edges, the surface of the fibre is rough, consequently the light that is reflected is dispersed in all directions, and these wools are dull in appearance. However, in any class of wool, the better the lustre is, the more valuable is the wool if other things are equal. The lustre is the most important feature of the bright wools, and as the property is chiefly dependent upon the retention of the polished surface of the outer scales, any treatment that will injuriously affect the latter must be avoided. Acids, caustic alkalis, strong scouring solutions, and hot water are liable to corrode the horny tissue of the outer scales, and thus diminish the lustre. Some of the mechanical processes through which wool passes tend to roughen the surface of the fibres, hence the wool is previously oiled in order that the fibres will glide over each other with as little friction as possible. The oil that is used must be readily saponifiable, because it has to be scoured out of the material at a later stage of the process of manufacturing; Gallipoli olive oil is found to be one of the most suitable.

Felting Property. In the 'felting' or 'milling' of wool the fibres may be matted or interlocked together (either in the fibre condition—producing felt—or in the woven cloth) to such a degree that they almost lose their identity as separate fibres. In the process of milling the material is moistened with soap and water, and is then heavily pounded or pressed by mechanical means—*i.e.* the fibres are submitted to crushing strains and released alternately. As the process continues the friction causes the material to become somewhat heated. The moisture and heat, acting on the plastic substance of the fibre, soften it and cause the individual cells to expand and become shorter; the strain, applied intermittently, entangles the fibres and causes them to rub against each other. It has been previously noted that the scales on the surface of the fibres project from the root to the tip, and that in consequence a fibre will slip more readily in one direction than the other. In the material under treatment the fibres are placed indiscriminately together, hence in rubbing against each other the outer scales become interlocked. The texture contracts or felts, and becomes at the same time thicker and denser. The degree of contraction varies according to the felting quality of the wool and the length of time that the material is under treatment. The felting of wool is due very largely to the interlocking of the outer scales, and it therefore follows that the best felting wools are those which have small scales with free protruding edges, a feature which is most in evidence in the fine, soft merino wools. To obtain the best felting results it is necessary for the wool to be also strong, elastic, and curly, and for the fibres to be fairly uniform in length. Strength and elasticity assist the felting by rendering the fibres capable of recovering from the strain that

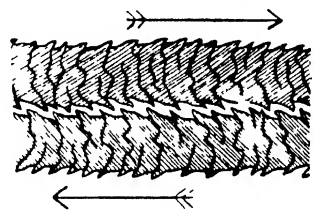


Fig 2.- Wool Fibres in Felting Position.

is intermittently applied, while the curliness brings the fibres more indiscriminately in touch with each other, and thus produces conditions suitable for the interlocking of the scales. The presence of an undue proportion of very short material naturally militates against the interlocking of the fibres. Cloths made from wool which possesses all the desired characteristics will shrink enormously. A weak, inelastic wool will not felt to a great extent even though the form of the scales is suitable, nor will a strong, elastic wool which has a smooth scale formation. The long, lustrous wools possess little or no felting property, in other wools the property is about in proportion to the stiff, thick, lustrous nature of the fibres. The felting property is very valuable in wools used for woollen fabrics which require to be heavily shrunk, such as billiard cloths, meltons, beaver cloths, &c., in which the surface of the texture has the appearance of a dense felted mass of fibres; whereas a wool of medium felting quality is more suitable for woollen cloths such as tweeds, flannels, and shawls. The long, lustrous wools are only suitable for cloths made of worsted yarns in which no felting is required, while the felting property is usually of little importance in worsted cloths in which the yarns are made from short wool, as the straight and smooth arrangement of the fibres in the threads tends to prevent the interlocking of the scales, so that the cloths are not subjected to heavy felting.

Hygroscopicity.—Wool absorbs moisture very

readily; under normal conditions the amount of moisture contained in raw wool is equal to about 14 per cent of the gross weight of the material, but according to the temperature and hygrometric condition of the atmosphere the amount may vary from 10 to 25 per cent and upwards. The weight of a given lot of wool is thus liable to change from day to day, with a corresponding effect upon its market value when bought by weight, if no allowance is made for the moisture. An official standard of moisture in wool has therefore been fixed, and establishments—termed conditioning houses—have been

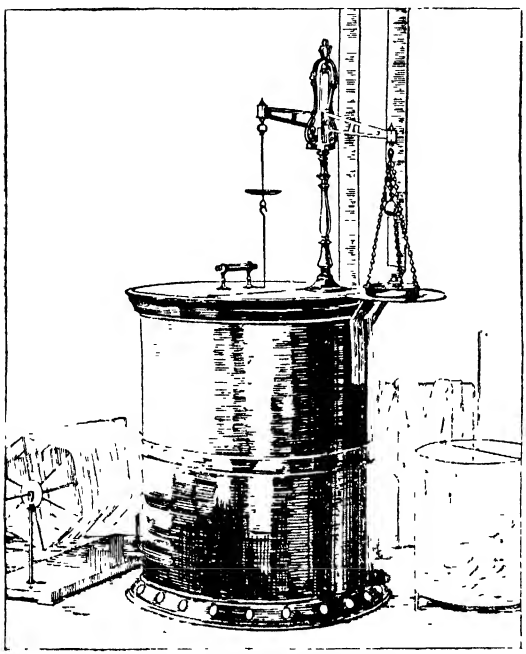


Fig. 3.—Conditioning Oven for Wool.

On the right a basket or cage is shown containing loose wool, and a reel which is used instead of the cage in conditioning 'tops.' On the left a stand is shown which is used in winding the 'tops' on to the reel. The two pipes at the rear conduct the air from the inner and outer cases of the oven.

installed in the principal textile manufacturing centres for the purpose of enabling the 'condition of wool' as to moisture to be determined. During the year 1910 over 96,000,000 lb. of wool, in different forms, passed through the Bradford conditioning house, and 218,151 tests for moisture were made.

Wool Conditioning.—The process of determining the correct invoice weight of a lot of wool is termed 'conditioning', and consists of adding to the absolutely dry weight of the material a standard percentage of regain. The 'standard of regain' varies according to whether the wool is in the raw state, or is partially or wholly manufactured, as is shown in the following list:—

	Amount of regain per cent	Moisture present per cent
Raw wool	16·00	13·80
Noils	14·00	12·29
Combed tops, in oil	19·00	16·00
Combed tops, dry	18·25	15·43
Yarns and cloths	18·25	15·43

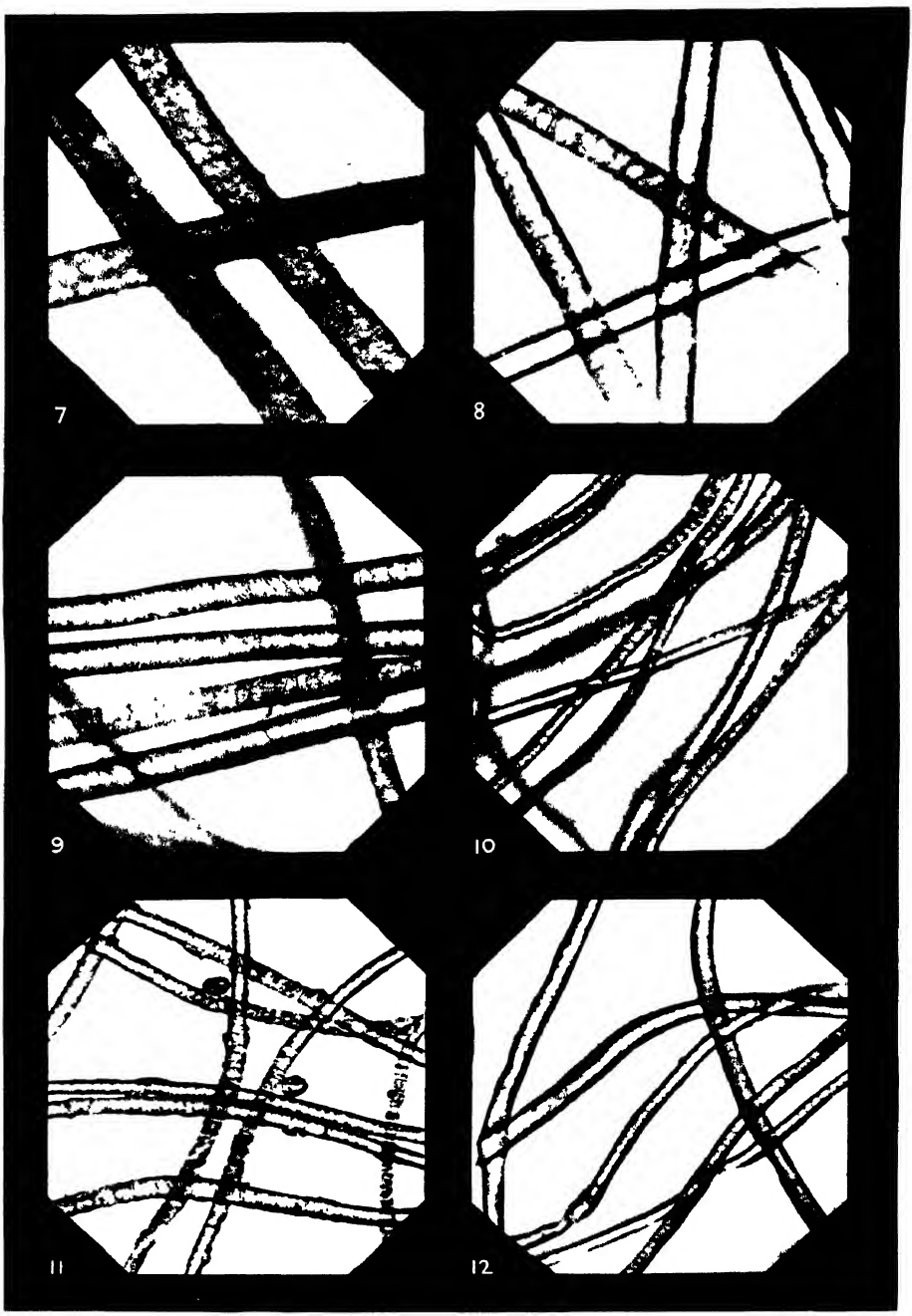
In the process of conditioning, the gross weight of the delivery of wool is first made, then small samples, taken from different sides and the interior of each bale, are put together to form a definite weight of—say, 1 lb. Great care is taken to get an average of the bulk, and as a rule duplicate tests are made of each bale. The conditioning apparatus consists of a tall cylindrical oven with an inner and outer case, between which there is a space of about 1½ in. all round where hot air circulates. The oven is heated by means of a circular Bunsen burner with numerous jets, which is placed below the outer case. A sensitive balance is firmly fixed at one side to the top of the oven, and from one arm of the beam a wire basket or cage is suspended directly in the centre of the oven. From the other arm of the beam is suspended a pan which exactly balances the wire basket. A thermometer is placed with the bulb about halfway down the oven, and the temperature is maintained between 212 and 230° F. (A lower temperature than 212 will not drive off all the moisture, while a temperature higher than 270 is liable to scorch the wool.) The sample of wool is put into the wire cage, and a weight to correspond is placed in the pan at the other side of the beam. A small cup is provided on the same side as the wire cage, in which weights are placed to compensate for the moisture driven off. The material is subjected to the heat (small weights, graded in tenths of a dram, being added to the cup) until the scales are balanced and remain stationary for five minutes, when the weights in the cup give the amount of moisture that was actually present in the sample. Assuming, for the purpose of illustration, that a bale of raw wool (not including tare) weighs 400 lb., and that a sample weighing 1 lb. (256 dr.) loses 32 dr.:

The original weight of the sample	=	256 dr.
The weight in the cup	=	32 dr.
The dry weight of the sample	=	224 dr.

The dry weight of the delivery $= 400 \times \frac{224}{256} = 350$ lb.

The true invoice weight = 350 + 16% regain = 406 lb.

With the foregoing particulars the 400 lb. of wool would be sold as 406 lb., if, however, the sample had contained 10 dr. of moisture, the dry weight of the delivery would have been



MICRO PHOTOGRAPHS OF WOOL FIBRES

[illegible]

7, China; 8, New Zealand Yearling; 9, Port Philip Cross-bred Lamb; 10, South American; 11, Cape Merino; 12, Cape

$400 \times \frac{216}{250} = 337\frac{1}{2}$ lb.; and the invoice weight—

$337\frac{1}{2}$ lb. + 16 per cent regain = $391\frac{1}{2}$ lb.

Affinity for Colouring Matters.—On account of its hygroscopic nature, wool readily absorbs and retains most colouring matters. It is found, however, that the lustrous wools, which have a hard, glossy, smooth surface, do not dye so readily as those that have scales with free edges. The more open surface of the latter allows the dye to penetrate the material more freely. When dyed in the same solution lustrous wools

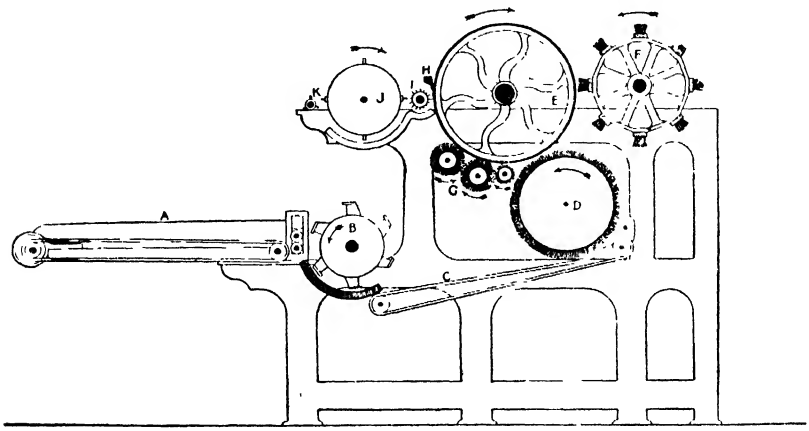


Fig. 4.—Burring Machine.

A, Feed lattice; B, Licker-in; C, Carrying lattice; D, Carrying roller brush; E, Comb cylinder; F, Fancy roller for Wool; G, Workers and strippers; H, Burring blade; I, Spiral roller; J, Beater roller; K, Beater for burrs.

appear much brighter in colour than fine wools, the colour in the latter appearing deeper and richer in tone. Certain colouring matters require to be used along with an acid (a mordant) before the material will take the dye; the acid, by opening the outer scales, enables the dye solution to penetrate the interior of the fibre. Wool from unhealthy animals, or from sheep that have died of disease, appears duller when dyed than wool taken from healthy sheep or from those that have been slaughtered. Also, wool that has been removed from the skins of slaughtered sheep by means of lime never dyes in such bright shades as similar wools taken from the skins by sweating or by chemical agency.

Natural Colour.—As a rule, the whiter wool is, the better it is for textile purposes, because of the greater facility with which light and bright colours can be dyed upon it. The best qualities of wool are nearly pure-white, but coarse varieties are frequently grey or yellow in line, while some classes of Shetland, Spanish, Persian, East Indian, &c., wools, and several varieties of wool han, are naturally black, fawn, or brown. The natural coloured wools can only be dyed in dark shades, but very frequently they are used in the natural state, and for certain purposes the natural colour gives the wool a special value. A natural coloured wool can be distinguished from one that has been artificially dyed, by the way in which the colouring matter is distributed within the fibre. In the former the pigment matter is chiefly contained between the cells in the form of dots or broken lines, whereas in the latter the colouring matter is distributed uniformly throughout the fibre.

Freedom from Vegetable Impurities and Kemps.—The presence of vegetable impurities in wool is always a source of trouble to the manufacturer, they do not take colour the same as wool and if not removed are readily seen when the material is dyed. Certain wools, particularly those of Buenos Ayres and Monte Video in

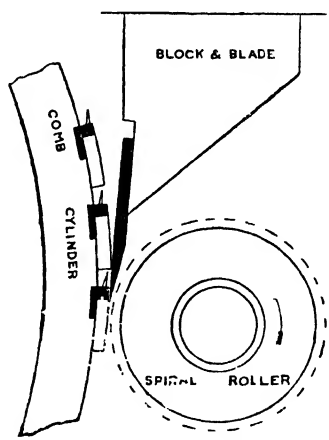


Fig. 5.—Details of Burring Machine.

South America, frequently contain a considerable quantity of round seeds (burrs) with projecting bristles which stick very tenaciously to the wool. Large particles of vegetable matter can generally be removed by mechanical means, and in figs. 4 and 5 a machine is shown that is

used for the purpose. The burry wool is conveyed by the parts lettered A, B, C, and D to the comb cylinder E, which is covered with transverse steel plates, from which fine needle-pointed teeth project in the direction in which the comb cylinder revolves. The wool is embedded in the teeth, but the latter are set so close together that the burrs stand out from the surface of the cylinder. The wool is carried upwards by the cylinder, but the burrs come in contact with the edge of a blade H that prevents them from going forward, and at this point they are acted upon by the spiral blades of a roller I, which removes them from the wool. The beater roller J takes the burrs from the machine, while the clearer brush F removes the wool from the comb cylinder E.

Small particles of vegetable matter, if only present in small quantities, are usually found to drop out of the material at one or other of the processes of manufacture. When the wool contains a large quantity of small impurities, however, it is necessary to employ chemical means in their removal. In this process, which is termed 'carbonizing' or 'extracting', the material, after scouring, is steeped in dilute sulphuric acid (about 3 Tw.), then squeezed between rollers, and afterwards dried by hot air. As the drying proceeds the acid concentrates on the vegetable matter and disintegrates it, in which condition it is readily reduced to powder and removed. The chemical process injures and reduces the value of the wool, hence it is only employed when the material is 'full' of vegetable impurities.

Another form of vegetable impurity, which causes an enormous amount of trouble, consists of small bits of bagging and string that get into the wool from the woolpack. This is generally made of jute, and during recent years, on account of the higher prices ruling, there has been a tendency to use a cheaper quality of jute in which a large quantity of short fibre is present. Instead of being hard and smooth, as was formerly the case, the presence of the short fibres causes the pack to be soft and fuzzy, with the result that after being tightly packed for some time, minute particles of jute are left adhering to the wool. If a bag is cut for the purpose of sampling the wool, the edges readily fray so that bits of jute thread get mixed with the material. It is also found that bits of string are gathered up with the wool in the sheep-shearing and packing sheds, and in the show warehouses. These impurities are so like greasy wool that it is practically impossible to sort them out, they get thoroughly mixed with the wool, are spun into the yarn and woven into the cloth, and are only detected when the material is dyed. Many dyes that are suitable for wool leave vegetable fibres unaffected, hence in the dyed cloth the bits of jute, &c., show as minute white particles, all of which have to be removed before the cloth is merchantable. The use of proper packing material (made of hard twisted and smooth jute or hemp yarn) is therefore of very great importance; and before the fleeces are placed in the pack the latter should be carefully shaken in order to remove any particles of canvas or string from the interior. There should be no free edges from which the threads will fray out, and in opening a pack for sampling the wool the sewing twine should be cut and not the bag, all bits of loose string being carefully removed and destroyed. Previous to the shearing, the shearing place should be entirely cleared of bits of straw, and in classing and packing the fleeces loose pieces of canvas and string should be carefully kept out of contact with the wool.

'*Kemps*' are principally found in coarse wools obtained from *badly bred* sheep, and from sheep living in hilly districts where the food is poor and where the animals are exposed to inclement weather. These defective fibres, which grow chiefly about the head, tail, and legs of the domestic sheep, are generally white, stiff, and brittle, and appear like opaque, dead hairs from which the scale formation and cellular structure are absent. The kempy structure does not always continue the full length of a fibre, in some cases it is found to alternate with the true fibre growth. In the production of woollen yarns the kemps mostly remain in the material,

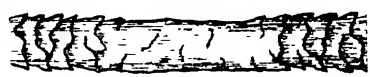


Fig. 6. Kempy Wool Fibre.

whereas in making worsted yarn they are removed to a considerable extent in the process of combing. On account of their greater stiffness, the kemps left in the material do not twist into the thread with the other fibres, but are mostly on the outside of the thread. They are entirely lacking in felting property, and have no affinity for colouring matters, so that when dyed they appear very much lighter than the other fibres. Wool which contains kemps is troublesome to the spinner and, in general, produces defective cloth, as a fabric, when dyed, appears streaked with white or light-coloured hairs. In certain cloths, however, the streaky, hairy appearance is a distinguishing feature, and when these textures have been fashionable, kempy wool—from such breeds as the Black-faced—has been eagerly sought.

Quantity of Wool Yolk.—Commercially the term 'wool yolk' is understood to include all the foreign matter that is removed from wool by scouring, &c. The quantity naturally present in wool varies extremely in different varieties, the loss in weight sustained by the removal of the impurities ranges from 15 to 25 per cent in the coarse and long lustrous wools, from 25 to 40 per cent in medium and fine cross-bred wools; and from 40 to 55 per cent (and even as high as 70 per cent in exceptional cases) in the fine merino wools. The amount that the wool loses appreciably affects the price to the spinner, and it is necessary for the wool buyer to be able to give a very accurate estimate of the amount that raw wool will 'yield' in the clean condition. Without taking the cost of scouring into consideration, a greasy wool at 12*d.* per lb. which loses 40

per cent will cost $12d. \times \frac{100}{100-40} = 20d.$ per lb.; but if the same wool lost 50 per cent the price would be $12 \times \frac{100}{100-50} = 24d$ per lb.

The quantity of wool yolk almost invariably serves as an indication of the quality of the wool. If the wool is heavy in grease, the fibres are well lubricated, and they are generally strong, elastic, fine, soft, and flexible, and of a good white colour. On the other hand, a small percentage of wool yolk indicates that the fibres are coarser and harsher, and possess more or less lustre.

Causes which influence the Qualities and Properties of Wool.—Sheep naturally grow wool suitable to the conditions under which they live; different conditions of climate, and of soil and pasturage, have produced differences in the characteristics of one class (or breed) of sheep as compared with those of another class, with a corresponding variation in the qualities and properties of the wool that is yielded. Wool attains the highest perfection as regards fineness, softness, uniformity of staple, and felting property in warm temperate climates *e.g.* Australasia. In cool temperate climates, length and lustre are the distinguishing features, as in certain varieties of British wools. In very hot climates the wool is generally dry and coarse, and irregular in staple, as for instance in East Indian wools, while in very cold climates, notably Iceland, the sheep are mostly covered with long coarse hair under which is a fine growth of wool. In any district the wool is affected according to whether the season is good or bad.

The good nourishment provided on moist loamy soil enhances the lustre and length of the wool and the bulkiness of the staple, grass from chalky or limy soil tends to make the wool harsh, while on light dry soil the fineness and softness of the wool are developed. Sheep living under the same conditions for generation after generation will always produce wool of the same characteristics, but by careful selection in breeding, protection from extreme variations in the weather, and the provision of a plentiful and regular supply of proper food, the class of wool produced can be materially improved, while its characteristic features are retained. Sheep permanently removed to a district in which there are different conditions of climate, soil, and pasturage, will in succeeding generations produce wool which suits the altered conditions, the distinguishing features of the original fleeces being gradually eliminated.

By crossing two different breeds of sheep, an animal is produced which possesses certain characteristics of both breeds, and there is a corresponding change in the quality of the wool. Thus a Leicester and an Australian merino cross produces an animal of medium size which yields a rather soft wool of medium length and lustre. In a cross such as the Blackfaced heath sheep with the Leicester, there is an improvement (as compared with the Blackfaced) in the quality of both the wool and the mutton; but, generally, where there are good markets for the meat, it is more profitable to increase the size of the carcass of the sheep than to develop the quality of the wool. To a great extent the efforts to produce a sheep that will fatten rapidly and yield a large and heavy carcass have had a very deteriorating effect on the fineness and softness of the wool. This is notably so in the case of a large proportion of the wools of Australasia and South America, where the development of the frozen-mutton trade, since about the end of the nineteenth century, has induced the farmer to cultivate sheep chiefly for the sake of the mutton, with wool practically a by-product. Where, formerly, only fine merino wool was grown, now there is a large and increasing quantity of cross-bred wool produced, much of which is similar to and competes in the market with home grown wool, with a considerable influence upon the price of the latter. In parts of Australia away from the coast and the rivers, however, on account of the lack of rainfall and the scarcity of the herbage, it is only possible for small sheep to be pastured, therefore a constant supply of fine merino wool is assured. Although the character of the wool may be altered by crossing the breed, if the environment is not suitable to the crossbreed the conditions of climate and pasturage will assert themselves, and, unless the cross is kept up, the wool year by year will become nearer and nearer to the variety natural to the surroundings.

During the period that sheep are unhealthy, or are subjected to unfavourable conditions, the wool grows more tender and finer in fibre. On the return of normal conditions the fibres regain their ordinary strength, but the presence of tender strata in the fleece greatly deteriorates its value. The wool is deficient in strength and elasticity, and handles very differently from healthy wool, and in testing a staple for strength the fibres are readily broken. The wool grows tender where a sheep is affected with scab, and a certain amount of matter is left on the wool by the scab, while vermin are liable to permanently discolour the fibres in places. The presence of these pests, by making the animal restless, causes its health to be affected, and the fleece to deteriorate generally. The application of injurious smears—particularly those containing tar—is very objectionable. Tarred staples have to be carefully removed from the fleece by hand; the tar does not wash out, and if allowed to go forward the hard lumps are liable to cause damage to certain machines, and subsequently result in defective cloth.

The features which distinguish a wool also distinguish the yarn and cloth made from it, and any defects in the raw material are felt in every process through which it passes, and are noticeable in the finished cloth. Very great differences, due to many causes, are found in wools grown by the same breed of sheep under similar conditions, and careful study of the differences and their causes is necessary, in order that, by proper selection and suitable cultivation, the wool may be brought into the best and most uniform condition. Uniformity in the raw material is essential to uniformity in the yarn and cloth made from it, and the nearer

the quality of a wool approaches the conditions necessary for a given purpose the more valuable it becomes.

The more fully the following conditions are attained in growing wool, the nearer will the material approach to the proper standard for manufacturing purposes —

1. The breed of the sheep should be suitable to the geographical and climatic conditions of the locality, so that the animals will flourish and produce wool that is of the best quality in its class.

2. The sheep should be of a good class of their kind, and the proper standard in each flock should be maintained by weeding out weak and faulty individuals. This facilitates the packing together of fleeces that are similar in quality.

3. The sheep should have a regular supply of good food, careful attention to health, and shelter from storms, in order that each fleece will be as *uniform as possible over the greatest possible area*, and each fibre sound and uniform throughout its length.

4. By careful selection the properties of strength, elasticity, suppleness, waviness, fineness and length should be developed in the highest degree; the colour should be a good white, and the lustre as pronounced as possible according to the class.

5. In preparing the wool for the market, clots of dirt, dung pieces, dirty and stained staples at the edges, should be removed, and each fleece should be tied up by a portion of the wool, all vegetable matter, such as string and straw being kept away from the wool.

Classification of Wools. Wool may be divided broadly into long-stapled and short-stapled varieties, which are almost opposite to each other in their special features, as is shown in the following comparative list —

Long Wool

Comparatively coarse fibre.
Harsh.
Wavy.
7 Inches and upwards in length.
Large, flat scales.
Lustrous.
Poor felting.
Small percentage of wool yolk.
Specially suitable for worsted yarn.

Short Wool

Very fine fibre.
Soft.
Curly.
5 to 2 inches and downwards in length.
Minute, protruding scales.
Dull.
Good felting.
Large percentage of wool yolk.
Specially suitable for woollen yarn.

Between the two extremes, wools of all lengths are produced by the various pure-bred and cross-bred varieties of sheep, and in a great degree wool varies in character according to length. There is found, indeed, to be a close relationship between the climate and the fineness, softness, curliness, length, number of scales, lustre, felting property, and quantity of wool yolk, all these features varying in due proportion to each other.

Commercially, wools are divided into four large classes, viz. (1) British wools, (2) colonial and foreign merino and cross-bred wools, (3) miscellaneous wools, (4) skin wools. For practical purposes each class is subdivided into several classes, and each class again may be divided into lambs', hog or hogget, and wether wool.

Lambs' wool, of a few months' growth, is always the finest wool of a sheep, but hog wool, which is the first clip of a sheep that has not been sheared as a lamb, is the most valuable. This is usually about sixteen months' growth, and is the longest clip, the staples are pointed, and they adhere to each other at the root end. The term 'wether' is applied to the second and subsequent clips, in which the staples are more or less square at the end, and when a staple is drawn out of a fleece it comes away without disturbing adjacent staples. The shearing of the wool causes the fibres to grow stronger, hence wether wool is coarser and less pliable than hog wool of the same class.

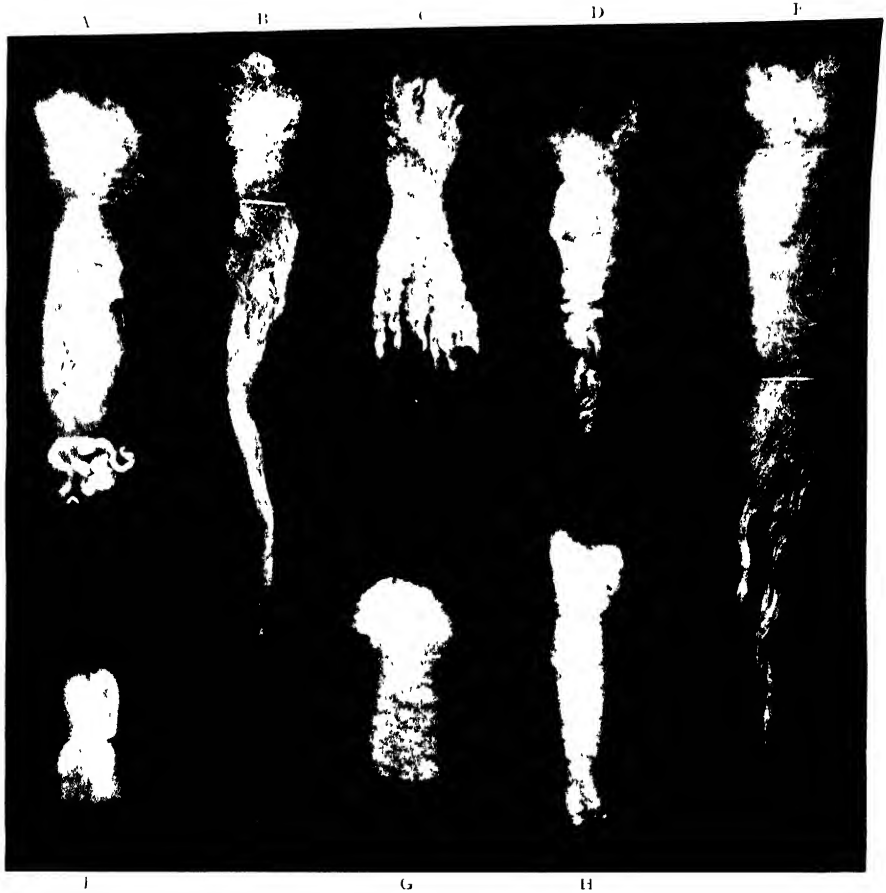
1. *British Wools.*—Owing partly to the great variation in the contour of the country, and partly to cross-breeding, British wools are very diverse in character, but for textile purposes they may be conveniently divided into Lustre wools, demi-lustre and half-bred wools, down wools, and special wools. These wools are bought privately or at local sales.

Lustre Wools. These are superior to any other hoggs wool in length of staple and lustre, and are produced chiefly by the Lincoln, Leicester, Romney Marsh, Wensleydale, Cotswold, and Devon hogs.

Demi-lustre and Half-bred Wools.—The term 'demi-lustre' is supposed to indicate that the wool is about half as lustrous as the brightest British wools, but it has become customary in the trade to class many wools of a distinctly cross-bred character, in which lustre is not a distinguishing feature, as demi-lustre. Also, it is usual to class any British wool that is not of a recognized pure breed as half-bred, although if the term is strictly applied it should only include the first cross between two distinct breeds. The demi-lustres include such wools as the Cheviot, Blackface, and Herdwick, and the Leicester and Border Leicester crossed with various breeds. It is also customary to class as half-bred, which produces wool of a well-recognized type, by a distinct name, thus, the wool produced by the Cheviot and Border Leicester cross is known as 'North'.

Down Wools.—These are produced on the chalky downs in the south of England and in the Midlands by the Southdown, Suffolk Down, Hampshire Down, Oxford Down, Dorset, and Wiltshire sheep. The Southdown is the English Merino, and occupies the same position as regards British short-wools that the Leicester sheep occupy in reference to British long-wools, both breeds being typical of their kind, and the most useful for crossing with other breeds. Southdown wool, however, is very much inferior in softness, fineness, and felting property to Australian merino, and is used for serge, flannel, and hosiery yarns.

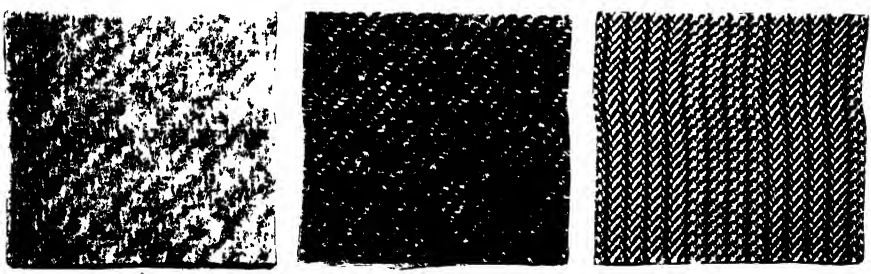
Special Wools.—These include Shetland, Dart-



STAPLES OF DIFFERENT CLASSES OF WOOL

(One-fourth size)

A Lincoln Wether B North Hal fbred Hogg C North Cheviot Hogg D Border Leicester Hogg E Cross-bred Hogg Leicester and Leicester Cross F Fine Merino Wether G South Cheviot Wether H Half-bred Hogg Leicester and Cheviot Cross



CLOTHS MADE FROM WOOL

A Heavily felted woollen fabric made from fine merino wool The thread structure is almost invisible B Medium felted woollen tweed made from Cheviot wool The thread structure is more clearly shown than in A C Worsted fabric made from fine Botany wool in which the thread structure shows very clearly

moor, Lonk, Welsh, and some classes of Irish wools. A good quantity is used in home industries, and some of the wools possess certain features, such as a good natural colour, which render them suitable for particular purposes

2 *Colonial and Foreign Merino and Cross-bred Wools* - The Merino breed of sheep, which had its origin in Spain, has been extensively cultivated in various parts of the world, and now produces the finest quality of wool known. The Saxony Electoral Merino, which produces the best European short wool, is derived from it; and in the United States a very fine wool is produced by the Vermont breed, which has been obtained by crossing the Spanish Merino with the French Rambouillet In Australasia, where the Vermont strain has been recently introduced with some advantages, merino wool has been brought to a high state of perfection, and in South Africa and South America the original stock has been greatly improved, although the merino wools of these countries are mostly somewhat inferior to the Australian merinos The term 'Botany' (derived from Botany Bay whence the first Australian wool was shipped) is almost synonymous with the term 'merino', but whereas merino is used to distinguish fine fibred wool produced by descendants of the original Spanish breed, Botany has a wider application, and is used to denote any fine wool that is superior to 56s in quality Where the conditions have been suitable the Merino has been crossed with the English Leicester, and colonial and foreign wools now include many different kinds, ranging from the very finest to the long-lustre variety It is customary in the trade, however, to classify all the wools below 56s quality, and which are not pure merino, as cross bred Formerly, nearly all the colonial wool was sold in London, but now large quantities are bought through agents at sale which are held in different centres in the Colonies These are shipped direct to the consumer, and an increasing quantity is being delivered to the Yorkshire manufacturers through the port of Hull South American wool is mostly consumed on the Continent, where Antwerp, Roubaix, and Havre are the chief centres, the quantity used in Britain being mostly shipped to Liverpool

3 *Miscellaneous Wools.*—These include the wools grown in East India, China, Russia, and Iceland, which are chiefly marketed in Liverpool With the exception of some of the Russian wool (Odessa) they are very inferior in quality Icelandic wool consists of a very coarse hair under which there is a fine growth of wool, the latter is combed out in the form of 'noil', and in this instance the noil is of greater value than the 'top', which is composed of the long fibres

4 *Skin Wools.*—These include all varieties, as they consist of the wools that have been removed, in the fellmongering industry, from the skins of slaughtered sheep (See 'Conditions in which Wool is put on the Market')

Hairs classed as Wool.—*Mohair.*—This is the most important wool hair. It is produced by the Angora goat, which is indigenous to the district surrounding the town of Angora in Asia Minor, from which the animal derives its name. In general characteristics mohair strongly resembles the best qualities of long lustrous wool, the outer scales being thin and flat and the fibre very smooth, but it is a more silky and more lustrous material than any variety of sheep's wool. The length ranges from 6 to 11 in., and the diameter of the fibres from $\frac{1}{1000}$ to $\frac{1}{500}$ in ; the handle is somewhat harsh, and the material is practically devoid of felting property The colour is usually a good white, but a small quantity of brown mohair—known as Van mohair—is produced in the district south of Angora which is of inferior quality Kid mohair is the hair from the young Angora goat Mohair is used in the manufacture of bright worsted fabrics, and in judging the material, lustre and length are of chief importance The spinners' qualities range from 28s to as fine as 60's in exceptional cases, the coarse qualities and mohair noils are used for carpets and blankets. The Angora goat has been acclimatized in other countries, and a considerable quantity of mohair is now produced in South Africa (Cape mohair) and the United States, and a small amount in Australia

Alpaca This material is produced by a cultivated goat (*Auchenia paco*), which it is found cannot be acclimatized in countries outside South America The fibre is softer and finer than mohair, and is similar in length but not quite so lustrous. Only a small quantity of white alpaca is produced, the colour generally being fawn, grey, brown, or black The material is chiefly used for bright dress fabrics

Vicuna - A small quantity of this material is obtained from a South American goat (*Auchenia vicunna*) which lives in a wild state The fibre is finer than alpaca and is very soft and delicate, the length ranges up to 7 in, and the colour is usually fawn or light-brown It is used for soft fabrics such as opera cloaks and shawls

Cashmere — This fibre is obtained from the Tibetan goat in Northern India and Tibet, which grows a coarse beard hair with a fine woolly undergrowth The latter, which usually amounts to only about 3 or 4 oz in each fleece, forms the cashmere of commerce, and is used in making the famous Indian cashmere shawls. The fibre is distinguished by its fineness and softness, the length is from 2 to 4 in, and the colour brownish-grey. (The term 'cashmere' is applied to a class of worsted yarn made from the best and softest qualities of Botany wool)

Camel Hair —The undergrowth of the camel and dromedary furnishes the camel hair of commerce, which is mostly used in its natural coloured state, as, for instance, in 'Jaeger' fabrics. It has a very soft handle, but is coarser in fibre than vicuna and cashmere, and the length is about 5 in.

Conditions in which Wool is put on the Market —Wool should be put on the market in a form which is most acceptable to the consumer, and in this respect colonial and foreign wools are mostly very superior to British-grown wools. In the former the greatest care is taken,

first, in skirting the fleeces and in removing dung bits and matted staples, and, second, in classing the fleeces so that throughout each bale the wool is similar in quality, the latter feature enabling the buyer to judge the quality with confidence from a small sample. With the exception of a few special classes, home-grown wools are in competition with an increasing supply of similar wools produced abroad, and until the British wool grower markets his produce in equally good condition the price of his wool will suffer in comparison, even though the quality is equally good. The British wool grower should keep in mind that the annual supply of home-grown wools is less than 150,000,000 lb., of which about two-thirds are consumed at home, whereas in Australia, the Cape, and South America over 1,100,000,000 lb are produced annually, of which about 500,000,000 lb are consumed in Great Britain. In the face of such an enormous quantity brought into and retained in the country, the result of a good or bad season at home has very little influence on the price of competing British wools, but a good or bad season abroad may affect the price very materially.

When bought by the user wool may be in one of five conditions, viz. (*a*) Greasy, (*b*) fleece-washed, (*c*) scoured, (*d*) skin—free from lime, (*e*) slipe—containing lime. In cleansing the wool of extraneous matter, the process and the agents used are varied according to its condition.

(*a*) In the greasy state, in which the bulk of the supply of wool is purchased, the material contains all the natural perspiration and wool fat, and foreign impurities. It is found, particularly as regards fine wools, that the grease keeps the fibres in the very best conditions during transport, so that it works better subsequently, and is superior as regards softness and flexibility. The presence of the grease, &c., however, makes it more difficult for the buyer to judge the 'yield' of the wool.

(*b*) In the fleece-washed state, the wool, previous to shearing, has been washed in a running stream on the sheep's back, which removes a large proportion of the foreign impurities and suint, but most of the wool fat is retained on the fibre. The wool has a neat appearance, and the yield is better and much more readily judged by the buyer.

(*c*) In the scoured condition the wool has received a preliminary scouring, subsequent to the shearing and previous to the packing, at the sheep-shearing station. This system is practised to a considerable extent by Australian wool growers whose stations are a long distance from a railway or from a navigable river, in order to reduce the cost of conveying the wool by wagon. The cost of transport by ship is also reduced, but against this has to be set the capital outlay on the scouring plant, and the cost of the scouring operation. Further, the wool is not in such excellent condition as when it is delivered greasy, as with the removal of the grease the natural preservative of the wool is taken away, and it is liable to become matted. Scoured wool requires to be again scoured by the user, but the loss in weight is comparatively small, ranging from 10 to 20 per cent as compared with about 50 per cent loss in greasy wool.

Classes (*d*) and (*e*) are wools derived from the skins of slaughtered sheep, the supply of which has been largely increased since the introduction of the frozen-mutton trade. A fair proportion of these wools is of good quality, but unsatisfactory treatment by the fellmongers and tanners in separating the wool from the skin, together with neglect in classifying, sorting, &c., depreciates the value of large quantities of the material. The wool should *not* be pushed out by pressure against the staples near the skin, as this brings all the fibres away, but it should be pulled from the skin with a firm grip of the staples, very short or kempy fibres being then left adhering to the skin. The 'pulling' should be accompanied by careful 'sorting' of the qualities, particularly in British and cross-bred wools.

Class (*d*) consists of wools that have been removed from the skins either by a process of sweating, or by chemical agency. In the sweating process, which is largely employed in France, the pelts are steeped in water and then hung in a warm, closed chamber. This causes the pores of the skin to open, and a slight decomposition is set up in the skin, with the result that the wool is readily pulled away. The wool is partly cleaned by the process so that it gives a good yield, and is in an open condition when it goes to the scouring. In the chemical process of removing the wool from the skins the chief agent is sodium sulphide, which is applied to the flesh side so that it will act upon the roots of the fibres. If brought in contact with the sulphide the wool is destroyed, therefore each skin is folded with the wool on the outside, and a pile is built up. Usually the skin is ready for the wool to be pulled out in a few hours, whereas in the sweating process several days' treatment is required, also both the pelt and the wool are in a better and more natural condition when treated with the sodium sulphide.

The term 'slipe' (class *e*) is used to distinguish skin wools in which lime has been used in removing the fibres from the skin. This system is chiefly employed in Britain for home-grown wools, it has a very deteriorating effect on the material, and is being gradually superseded by the other methods. The skins are softened in water, and a mixture of lime and water is applied to the flesh side of the skins. The skins are folded, or put together in pairs with the limed sides in contact, and a stack is built up, in which condition they are left until the lime has decomposed the roots of the fibres, when the staples are readily pulled away. Previous to the pulling the limed skins are rinsed with water, preferably in a running stream. If the operation is not properly performed the wool becomes more or less loaded with lime, which penetrates the fibres, making them harsh to the handle and grey and dull in appearance. The scouring is effected with difficulty because the lime decomposes the soap, while when dyed the wool takes a dull tone of colour.

Classing and Sorting Wool.—In the same breed of sheep, living in the same locality, the

quality of the wool is liable to vary considerably in different animals. It is therefore customary to classify the fleeces, and to put together those which are similar in quality, hog and wether fleeces, for instance, being generally used separately. Furthermore, in different parts of the same fleece, particularly in the long and coarse varieties, there is a great variation in the length, softness, and fineness of the fibres. If all the different qualities in the fleece were used together, the poorer qualities would reduce the value and usefulness of the better qualities; the thread spun from the material would be defective because the machinery could not be adapted to suit all the different types of wool included. It is therefore customary to divide up each fleece according to the different qualities present. This operation, which is performed by hand and is known as 'wool-sorting', enables the several qualities found in the fleeces, each to be utilized for the purpose for which it is best fitted, the finest wool being employed for fine yarns, and the lower qualities for cheaper grades. The better the breed of the sheep, and the finer the quality of the wool as a whole, the less variation is there in the different parts of a fleece; and it is found that for ordinary purposes the Merino and fine cross-bred fleeces of Australasia require no sorting at all beyond the removal of large impurities and stained locks. These fleeces are so well classed at the sheep-shearing station, and each fleece (from which the coarse wool, or skirtings, from round the legs, tail, &c., have been removed before packing) is so uniform in quality, that before being used the fleeces are only 'looked over' (examined for defective staples), except when it is required to produce a specially fine quality of yarn. In the latter case the best parts of the front portion of the fleeces may be used separately.

Coarser colonial wools and home-grown wools vary so much in different parts of the same fleece that they have to be properly sorted, and as many as from six to fourteen sorts are made from a fleece, according to the kind and quality of the yarn that has to be made. Figure 9 illustrates in a general way the position that the different qualities occupy in a long lustre wool fleece, no hard-and-fast rule, however, can be followed, as the qualities merge into each other and vary in different fleeces. In the worsted trade it is customary to designate the qualities by numbers, which are supposed to represent the 'counts' of the yarn to which the wool will spin. The 'count number' indicates the number of hanks of 560 yd. each contained in 1 lb. of yarn. Thus, in 1 lb. of 40's worsted yarn there are $40 \times 560 = 22{,}400$ yd., whereas in 1 lb. of 60's yarn there are $60 \times 560 = 33{,}600$ yd. A wool that will spin as fine a yarn as 40's count is classed as 40's quality, but if it will spin as fine as 60's count it is classed as 60's quality—the better the quality the higher the number. In actual practice, however, the quality number of the wool represents the fineness of the fibres rather than its spinning quality, and a wool which is equal in fineness to 60's quality would be classed as 60's, although, on account of the length and uniformity being deficient, it might spin no finer than 50's yarn.

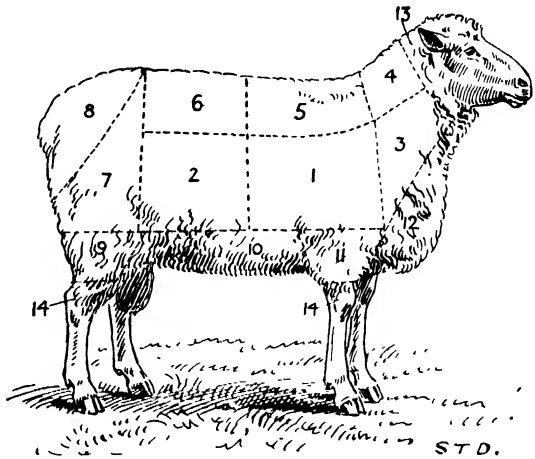


Fig. 7.—Leicester Ram, showing Sortings.

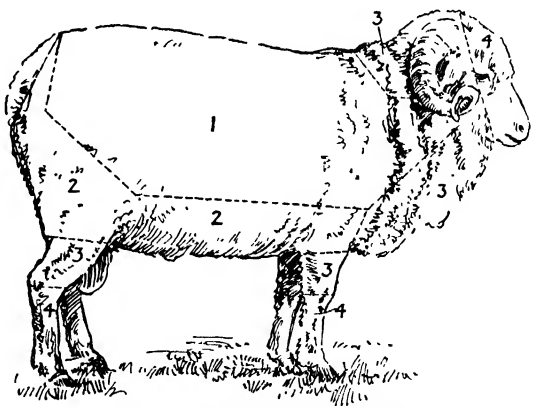


Fig. 8.—Spanish Merino, showing Sortings.

The following terms are also used in the worsted trade for the different qualities:—

Fine matching from the shoulders equivalent to 44's quality.

Blue matching—from the neck—equivalent to 40's quality.

Neat matching—from the middle of the sides, and the back—equivalent to 36's quality.

Brown matching—from the haunches—equivalent to 32's quality.

Britch—from the hind legs—equivalent to 21's quality.
Coatail—very coarse wool from the legs—equivalent to 18's quality.

Downrights is a term applied to short but fine wool from the neck, *seconds* to wool from under the body, and *abb* to wool from the haunches and legs. It is only in the best English lustre fleeces that the wool is fine enough to be classed

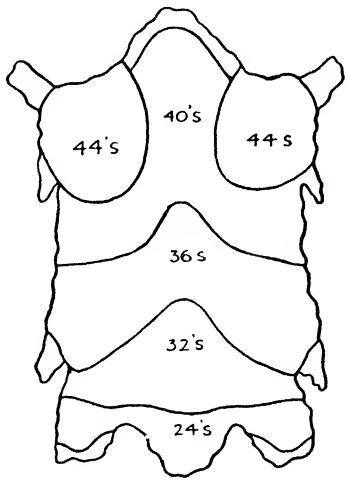


Fig. 9

as fine matching; in a rather coarse fleece the finest wool might be only equal to blue matching, and in a 'strong' fleece to neat matching.

Colonial cross-bred qualities and English wools are sometimes designated as 10's, 9's, 8's, 7's, 6's, and 5's, which are respectively equivalent to 56's, 50's, 46's, 40's, 36's, and 32's 'top maker's' qualities. Hog fleeces sometimes contain wool of a specially high quality, and the term 'pick', 'super', or 'selected' is then added to the quality number.

Fine merino wools are classed by quality numbers as 60's, 64's, 70's, &c., to which the terms 'ordinary' or 'super' may be added. If sorted, the front portion of a Merino fleece of 60's quality will yield a wool of 64's quality, and of a fleece of 64's quality a wool of 70's quality, and so on.

Colonial fleeces are skirted previous to being classed, and in fig. 10, which represents the different qualities in a cross-bred fleece, the parts which are taken away are shown outside the dotted lines. The skirtings are classified into several qualities, each of which is packed separately.

In the process of sorting, a fleece is spread out on a flat surface composed of wire netting, through the meshes of which dust and dirt fall. As similar qualities are found on the two sides of a sheep, the fleece is first split down the centre, then matted dirty locks, and staples stained by branding, are pulled or clipped away. The sorter, governed by the senses of touch and sight, divides the fleeces into the different qualities—commencing with the low quality at the britch—and places each in a separate basket.

In sorting dusty and dirty fleeces a fan is employed, which causes a current of air to pass down through the wool so that the dust and dirt are prevented from rising, and are caused to pass through the meshes of the wire netting to be discharged in a dust chamber situated outside the building. Certain classes of wool, *e.g.* wools of China, East India, Persia, Asia Minor, and Turkey, and the wool-hairs mohair, alpaca, and camel-hair, are liable to contain a deadly microbe (Anthrax bacillus), a whole bale of wool may be infected by a fleece being included (through the greed of the native grower) from an animal which has died of splenic fever. If a germ is introduced into the lungs, or through a sore on the body of the sorter, anthrax, or wool-sorter's disease, is caused, which in most cases is speedily fatal. Special regulations as to cleanliness, &c., are rigidly enforced in the sorting of the wools. The bales are first opened, and the fleeces well shaken in a room with a perforated hollow floor, and a downward draught of air is engendered by means of a powerful fan to prevent the dust from rising.

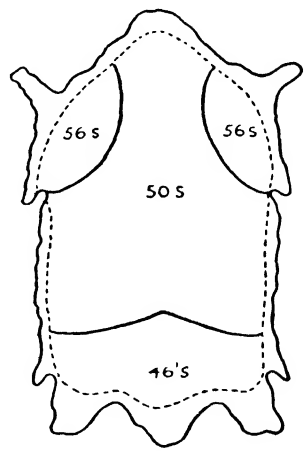


Fig. 10

The subsequent sorting of the fleeces is performed with a strong downward air current acting on the wool.

Wool Scouring.—The wool grease, which is exuded upon the fibre by the sebaceous glands, consists of cholestrin and isocholestrin, in the free state, and in combination with oleic and fatty acids. The substance is insoluble in water, but is soluble in volatile solvents, such as ether, benzine, and bisulphide of carbon; also it forms emulsions in soap and alkaline solutions. The dried-up sweat or 'suint', which consists chiefly of the potash salts of fatty acids, is soluble in water, but is insoluble in volatile solvents. The mechanical impurities, sand, earth, &c., are enveloped by the grease and suint, and fall away from the fibres when the latter are removed.

In the British system of scouring wool the material is passed through three or four machines which successively range from 9 to 5 yd long, and contain from 1800 to 750 gal of scouring solution. Each machine consists of a large tank or bowl and a smaller perforated tank, in which the wool is treated with the scour while it is gently agitated and moved through, the time of immersion in succeeding machines ranging from 3 to 1½ min. The wool is fed into the

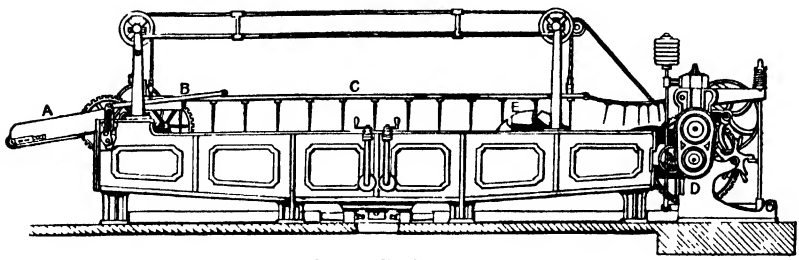


Fig. 11.—Wool Scouring

A, Feed sheet. B, Perforated immersed plate. C, Prong frame. D, Squeezing rollers. E, Revolving buckets. The wool is passed through the scouring solution by means of a series of rakes or prongs that are supported by a tubular framework to which an elliptical motion is given.

first machine by hand, and then passes automatically through and from one machine to another, at the delivery end of each machine it is tightly squeezed between rollers. The strongest scouring solution is contained in the first tank, in which the greatest amount of impurity is taken out, when the liquor in this machine is duty it is run off, that from the second machine is run into the first, that from the third into the second and so on. The last bowl, which is used chiefly for rinsing the wool, is filled up with weak, clean suds, after passing

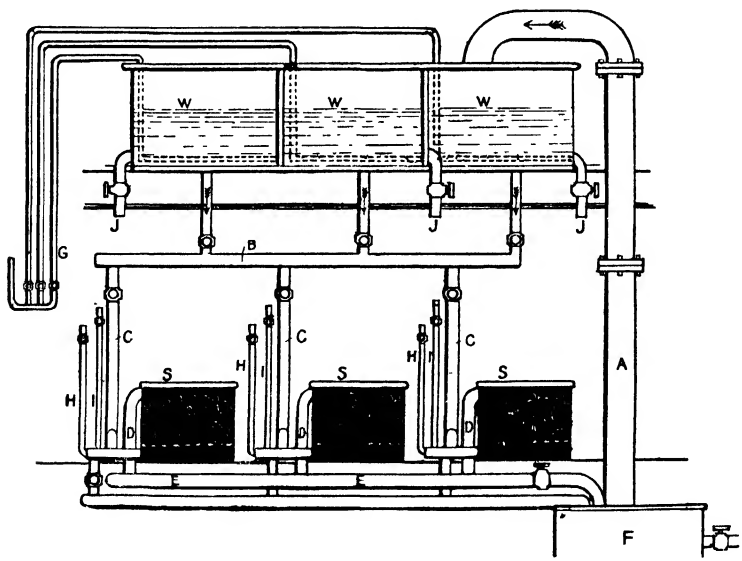


Fig. 12.—Wool-steeping Apparatus

A, B, C, D, E, Parts of the water circulatory system. F, Settling and feed-water tank. G, H, I, J, Parts of the steam circulatory system. S, S, S, Steepers (dotted line shows perforated tray through which the steam is driven). W, W, W, The water tanks.

through the squeezing rollers of this machine the wool is knocked upward and forward by a revolving beater, and delivered in a lofty, open condition.

The principal scouring agents are hard or soda soap, soft or potash soap, carbonate of soda, carbonate of potash, and ammonia. Potash is less severe in its action than soda, and is principally used for fine qualities of wool; soda is used as an ingredient in washing strong

coarse wools. Strong solutions of the ingredients are made separately, and the proper quantity is added in each machine to bring the liquor to the required strength. It is particularly necessary for the soap to be free from caustic alkali, as this has a very destructive action on the wool. The natural potash salts present in the suint materially assist in the cleansing operation. The temperature of the suds ranges from 125° to 105° F. in succeeding machines, a high temperature injures the wool, particularly the lustrous varieties. Soft water is necessary; if hard water is used some of the soap is decomposed and wasted, while an insoluble lime soap is formed which is deposited on the wool and is very difficult to get rid of. The wool requires to be agitated in order that the solution will penetrate the lumps, but if it is agitated too much it becomes matted and stringy. Thorough scouring is necessary, if dirt is left in, the material does not work so easily in subsequent processes, and when dyed the colour is uneven. Overscouring tends to remove some of the natural oil present in the fibres, the wool is made harsh, and the lustre is dulled.

By-products from Wool.—In Britain the waste liquor from wool washing is very largely run away into the streams and rivers. On the Continent, and in some instances in this country, the liquor is collected, and by suitable treatment the grease from the wool, and the fatty matters from the soap used in the scouring, are recovered. The recovered grease is used in its crude form as a lubricant, and for smearing sheep in winter in cold climates, but by distil-

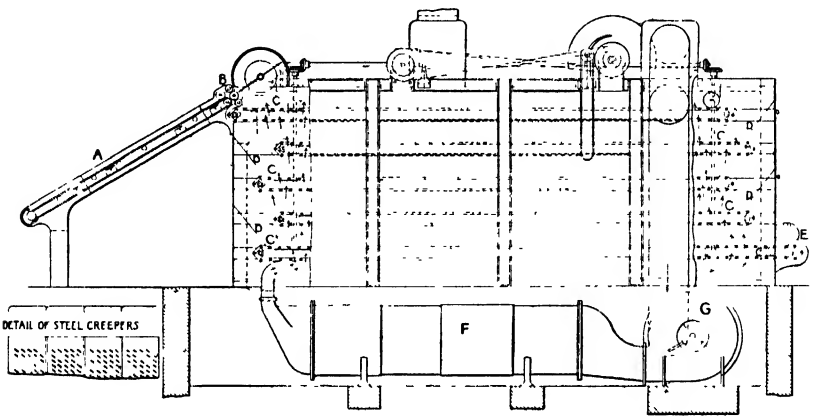


Fig. 13.—Patent Wool Dryer.

A, Feed lattice. B, Feed rollers. C, Creeper wool lattices. D, Slanted guide plates. E, Delivery rollers. F, Heater. G, Fan. Arrows show direction of air currents.

lation it may be made to yield stearine and olein. In its purified form the wool grease yields 'lanolin', which is used in making up certain ointments and as an emollient preparation for the skin. The residue contains a considerable amount of potash and is used as a manure.

A system of treating wool with warm water, previous to the operation of scouring, is extensively practised on the Continent, and is growing in use in Britain. The water dissolves the soluble impurities (the suint), which consist chiefly of potash salts, and from this source a large quantity of carbonate of potash is obtained.

In another system, which is employed to a limited extent, the wool is placed in enclosed chambers, and is treated first with warm water and then with volatile solvents. The former dissolves the suint and the latter the wool fat, and subsequently the by-products are recovered in a very pure form.

Wool Drying.—After the scouring operation the wet wool is taken to a drying machine that consists of an enclosed chamber in which there is a series of horizontal moving lattices. The material is fed on to the topmost lattice, from which, after it has travelled to the end, it drops to the next, and passes back, the process being repeated at each level until it reaches the bottom lattice, which conveys it out of the machine. By means of a fan air is forced through a heater and up through the wool, and the speed of the lattices is regulated to give the proper length of time for the hot air to act upon the fibres.

The following terms, in addition to those previously given, are applied to wool.—

Apron is applied to the folds of wool hanging in front of a sheep.

Astrakhan wool is a special curly wool which is obtained from kids taken before birth from certain Eastern sheep.

Come-back wool is due to crossing two breeds of sheep, and then crossing the half-bred with one of the original breed.

Cotted wool contains masses of fibres which have become matted and entangled on the sheep's back. It is usually due to disease and restlessness on the part of the sheep.

Culling is the selection of inferior sheep from those of a better type.

Eau wool is a Scotch term applied to the second and

subsequent clips, which in England are termed 'wether wool'.

Fallen wool is wool taken from sheep that have died

Fribs are short tufts of wool caused during shearing by second cuts being made on the staples.

Lean wool is over-fine and weak, and has a poor handle and works up unsatisfactorily.

Lotty is applied to wool of greater than average growth, which has a full appearance and tends to expand

Middle-woolled is applied to sheep that are intermediate between the long and short varieties

Plain wool is wool in which the curliness or waviness and the staple formation are scarcely discernible

Sappy wool contains a superabundance of grease, and is therefore a bad yielding wool.

Say-cast is the coarse part at the tail end of a fleece

Seedy is applied to wool which contains a large quantity of vegetable seeds

Shatty wool is a long and densely grown wool

Shanklings are very coarse parts shorn off the legs of the sheep

Shives are small particles of vegetable matter (other than burrs) found in wool

Strong wool has a thicker and coarser fibre than the average of a class, and is thus of inferior quality

Toppings or dags are matted dirty staples caused by foreign matter adhering to parts of the fleece They are removed by the sorter, and are more frequently found when the season has been bad

Tufted wool has the staple formation disorganized, the fibres in one staple adhering to those in another

Warp wool is thick, straight, and hard in fibre

Yearling or teg wool is the first clip of twelve months' growth from an animal that has been clipped as a lamb

Wool substitutes, or re-manufactured wools, consist of wastes produced in the various processes through which the material passes, and of wool recovered from 'rags' They are chiefly used in the woollen trade for cheapness, and are classified as noil, waste, flock, shoddy, mungo, and extract The trade is very extensive, about 180,000,000 lb of rags being used annually in Great Britain, of which over 100,000,000 lb are imported

Noil is practically new wool, consisting as it does of the short material that is removed from the wool in the combing process in worsted-yarn making It is the best of the re-manufactured material, and in many cases it is almost as useful and valuable in the woollen trade as new wool. The length ranges from ½ in upwards, and the qualities of softness, fineness, colour, &c, vary according to the class of wool from which it is derived Noils are classified as English, cross-bred, Botany, mohair, and alpaca, according to their origin

Wastes vary very much in quality according to the material, and the process of manufacture in which they are made Thus, the waste made in 'carding' is soft, so that it is readily worked up again with little or no injury to the fibre, whereas the waste made in spinning and weaving chiefly consists of twisted threads which have to be 'pulled' or 'ground' into the fibre state before the material can be again used.

Flocks are produced in the cloth-finishing operation of milling, raising, and cropping, by which names they are known. They are used in low woollen yarns, for wallpapers, and for stuffing mattresses.

Shoddy and *Mungo* are produced by tearing up rags made of wool, such as worn-out garments, tailors' clippings, manufacturers' patterns, &c, shoddy being made from soft materials, *eg* knitted fabrics and shawls, and mungo from hard, firm cloths. The terms 'old' and 'new' are applied according to whether the material is produced from rags that have been worn or otherwise The rags are subjected to a pulling and grinding action which reduces them to the fibre condition again, but the length of the fibres necessarily suffers (to a greater degree in mungo than in shoddy), and the material is very inferior in quality. Many of the properties of wool, however, are retained, and heavy, warm garments, which would be out of the reach of many people if made of new wool, are produced at a cheap price

Extract is made from rags composed of cotton and wool, from which the cotton is extracted by chemical means (as in the removal of vegetable matter from wool) The wool material that is left is then pulled into the fibre state in the same manner as in the manufacture of shoddy and mungo

The Wool Industry - A brief description of the principal types of yarns and cloths that are made from wool will assist in a proper understanding being obtained of what are desirable features in the fibre Except in the case of 'felt' - which consists simply of fibres which are indiscriminately matted and felted together - the first object is to arrange the fibres in the form of a spun thread which is sufficiently strong to enable it to stand the strain of the operation of weaving The fibres are, by a series of processes, arranged in proper position in relation to each other in the form of a very thin sliver, and twist is inserted in order to wrap the fibres round each other so that they will adhere and give the necessary strength to the thread In addition to the strength required for weaving purposes, a thread should be of the proper size, and as nearly uniform in thickness throughout the length as it is possible to attain, it should also possess the properties of fineness, softness, lustre, and power to shrink or felt, according to the type of cloth that is required Cloth is made by interlacing transverse or weft threads with longitudinal or warp threads, the former, during weaving, are subjected to very little strain, whereas the latter are placed under considerable tension Firmness and strength are therefore absolutely necessary features of the warp threads; but in getting these, softness and lustre, to some extent, have to be sacrificed, hence the latter features are chiefly obtained in the weft threads The term 'weft', or 'warp', is sometimes used in conjunction with the quality number given to wool, as it is frequently found that a wool that is particularly suitable for weft is much less suitable for warp, and vice versa; but in very many cases the same wool can be used for either weft or warp The features which distinguish a wool also distinguish the yarn and cloth made from it, and any defects in the raw material are felt in every process through which it passes, and are noticeable in the finished cloth

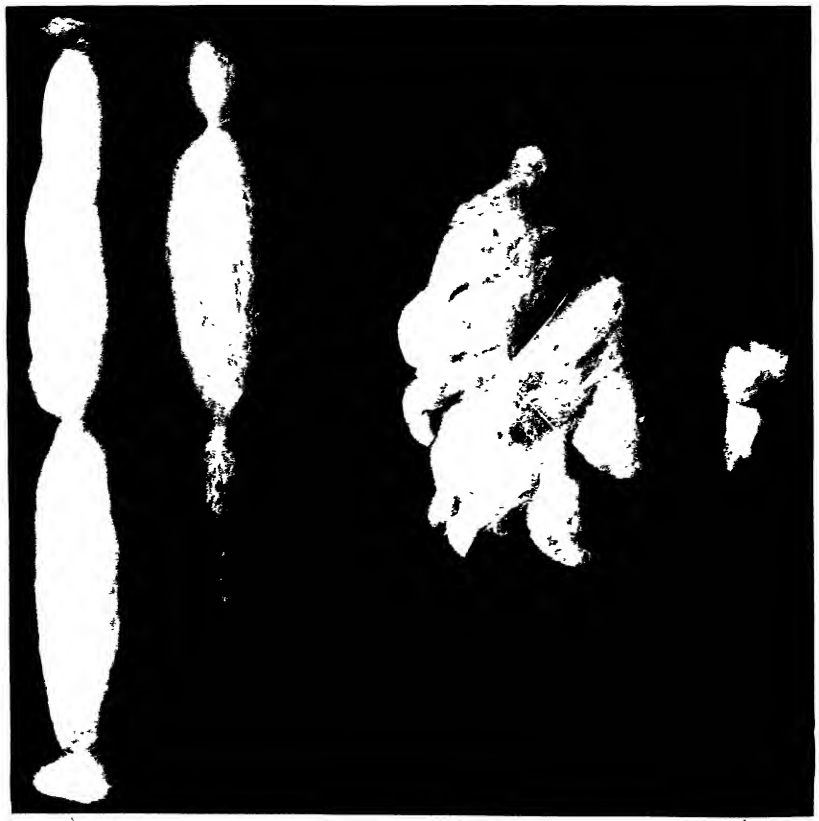
The yarns made from wool may be divided broadly into worsted and woollen. Frequently the raw material is classified into 'wools suitable for worsted yarn' (long wools), and 'wools suitable for woollen yarn' (short wools); also the term 'combing' is applied to the former and 'carding' to the latter. Such a classification of wools is, however, erroneous, because, although long wools are specially suitable for worsted yarn, and short wools for woollen yarn, the same class of wool can be made into either worsted or woollen. The difference between the two classes of yarns is not due to the nature of the wool, but to the difference in the principles upon which the yarns are constructed.

Worsted Yarn.—In producing a worsted yarn the fibres (in the scoured condition) are first arranged as straight and as parallel as possible with each other in the form of thick slivers by a process of 'preparing', then by the operation of combing the short fibres are removed from the slivers in the form of 'noil', while the long fibres go forward and form the 'top'. The noil is a waste although a valuable waste—in worsted-yarn making, the amount of short fibre taken out varying from 5 to 10 per cent of the weight of the clean wool, the top consists of thick slivers in which the longer fibres are arranged in straight and parallel order. By a process of drawing, the thick top is reduced to a very fine sliver or 'roving' from which the thread is spun. The processes of drawing and spinning promote the straightness and parallelism of the fibres. In a typical worsted yarn no short fibres are present, the fibres are fairly uniform in length, arranged as straight and parallel with each other as possible, and the thread is very uniform in thickness. The smooth and parallel arrangement of the fibres enhances the lustre of the material, but it reduces its felting property. It will be evident that length, and uniformity in length in particular, are very important features in wools that are combed, if there is a big proportion of short fibres present there is a relatively large amount of waste, which increases the cost of the yarn. Formerly only wools of good length were combed, but with present-day machinery it is possible to comb any wools from 3 in. and upwards in length. The process of preparing wool for combing, however, varies according to the length of the material, wools about 7 in. and upward in length are prepared by a process termed 'gilling', while short wools are prepared first by 'carding' and then by gilling. There are thus two distinct classes of worsted yarn, viz. (1) A lustrous worsted yarn, made from long wool prepared by gilling, which is bare and open in structure, but in which the lustre of the raw material is developed in the highest degree. This class of yarn is suitable for cloths in which brightness of appearance is of equal or more importance than warmth, and for such cloths lustre and length are the most desirable features in the wool. (2) A Botany or merino worsted yarn, made from short wool prepared by carding, which possesses little lustre, but is very full and soft to the handle. This class of yarn is suitable for light- and medium-weight cloths in which softness and warmth are desirable features, and in this case fineness and softness are of the greatest value in the wool.

Woollen Yarn.—A woollen thread is directly opposite in character to a worsted thread; the processes employed are fewer than in worsted-yarn making, and (after the scouring operation) consist chiefly of scribbling, carding, condensing, and spinning. None of the short fibres are removed from the wool, and the processes of woollen scribbling and carding, which are similar in effect, tend to mingle the fibres indiscriminately together. The condensing process simply divides the carded material into thin slivers, from which the spun thread is produced. In none of the processes is there any attempt to lay the fibres straight and parallel with each other, but rather the reverse. Fibres of any length can be spun on the woollen principle, but it is usually not economical to employ wools that are longer than 7 or 8 in., as the long fibres are liable to be broken in the machinery. Wools that are too short and poor for worsted can always be employed for woollen, and it is claimed by woollen spinners that they can spin any material 'that has two ends to it'. The quality of the yarn and cloth necessarily suffers if the raw material is inferior. The best woollen textures are made from merino and Botany wools, in which fineness, softness, and *aptitude to felt* are the most desired features, medium fabrics of the Tweed type from medium wools, such as Cheviot, in which the felting property is rather deficient, but which are true and sound in fibre, with a rather crisp handle, while in the low-class woollen trade the re-manufactured fibres shoddy, mungo, and extract (mixed with a small quantity of good wool, noils, or cotton to enable it to spin) are employed. A typical woollen yarn contains very short fibres, the fibres vary extremely in length, and they are arranged as indiscriminately as possible in the thread, the latter feature promoting the felting property of the material. The yarn is dull in appearance, dense, full to the handle, and uneven in thickness.

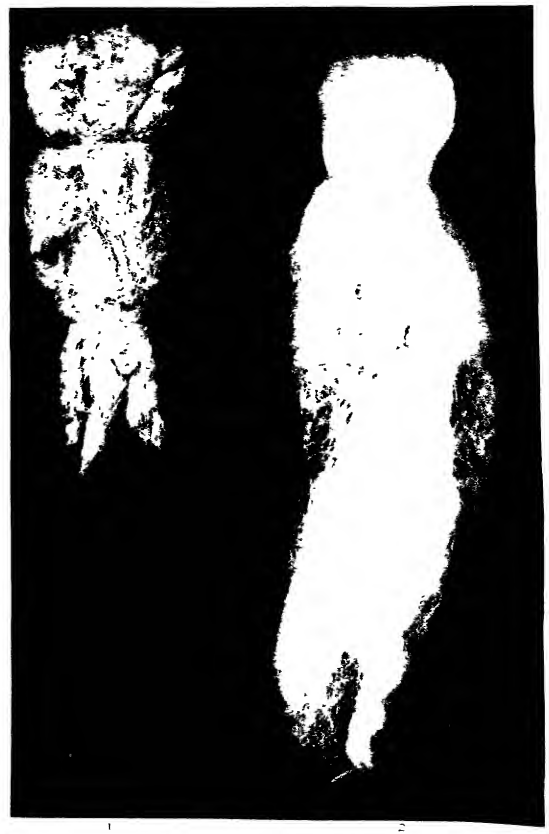
Hosiery and *carpet* yarns are spun on both the worsted and the woollen principle, but they are always required to handle very full, and for this reason, when made on the worsted system only a small proportion of the short fibres is combed out, while in some cases the combing operation is entirely omitted. Wools are therefore suitable for these yarns which contain too large a proportion of short fibres to be economically used for ordinary worsted yarn.

In the accompanying table some of the features and uses of different classes of wool are given for comparison, but it will be understood that the particulars are only of a general character, as many classes of wool vary considerably, and by sorting are made suitable for many different purposes. 'Price' is one of the most important factors to the manufacturer, and very frequently a different class of wool is employed for a certain purpose when a shortage in the supply of the wool that is generally used has caused the price of the latter to be prohibitive.



PRODUCTS OF COMBING IN WORSTED YARN MANUFACTURE

A. Top of a Long English wool. B. Sliver of the length of the fibres in a Noil. C. Noil. D. Sliver of the fibres of equal length.



STAPLES OF LONG ENGLISH WOOL

Class of Wool	Approximate Quality Number	Length, Uniformity, and Trueness	Average Fineness	Handle	Waviness	Lustre and Colour	Felting Properties	Uses
Low Scotch Low English	28's	5–15″ Irregular, weak, brittle, and kempy	$\frac{1}{750}$″	Harsh	Straight	Grey, non lustrous	Poor	Carpets, cheap hosieries
Medium Scotch Low medium English Low cross-bred	32's	6–14′ Irregular, weak	$\frac{1}{850}$″	Fairly harsh	Straight	Slightly lustrous	Poor	Low serges and suitings carpets, blankets
Fine Scotch Medium English Low medium cross bred	36's	8–13″ Fairly uniform, fairly sound	$\frac{1}{950}$″	Fairly soft	Nearly straight	Fairly lustrous	Poor	Tweeds costumes, serges, carpets, blankets
Best Scotch Fine English Medium cross-bred	40's	6–11″ Uniform, sound	$\frac{1}{1000}$″	Fairly soft	Slightly wavy	Lustrous	Poor	Bright dress fabrics, dress serges, medium suitings
Best English Long cross-bred	44's	8–12″ Uniform, sound	$\frac{1}{1100}$″	Fairly soft	Wavy	Very lustrous	Poor	Best lustre cloths, dress fabrics, linings
Shorter British and Colonial cross bred	46's	4–9′ Fairly uniform sound	$\frac{1}{1200}$″	Fairly harsh	Wavy	Fairly lustrous	Fair	Serges, medium suitings costumes, blankets, hosieries
Downs Medium Colonial cross bred	50's	3–7 Fairly uniform, sound	$\frac{1}{1300}$′	Fairly harsh	Fairly curly	Fairly lustrous	Fair	Fine serges, medium coatings, flannels hosieries
Finest Downs Fine cross bred Low merino	56's	4–6′ Fairly uniform, sound	$\frac{1}{1400}$′	Fairly soft	Fairly curly	Fairly lustrous	Fairly good	Medium and fine coatings, soft dresses and costumes, flannels
Finest cross-bred Botany skin wools	60's	2½–5″ Uniform, sound	$\frac{1}{1600}$′	Soft	Curly	Non-lustrous fairly white	Fairly good	Fine coatings, worsted and woollen suitings, dress fabrics, linings, fine hosieries
Botany fleece and Merino skin wools	64's	2½–5″ Uniform, sound	$\frac{1}{1700}$′	Soft	Curly	Non lustrous, good white	Good	
Fine merino (classed fleeces)	70's	3–5 Uniform, sound	$\frac{1}{1900}$″	Very soft	Very curly	Non lustrous, good white	Very good	Very finest worsted and woollen cloths
Finest merino (sorted fleeces	80's to 90's	3–4½″ Very uniform, very sound	$\frac{1}{2000}$″	Very very soft	Very curly	Non lustrous, very white	Very very good	

[W. Wa.]

Wool and Woollen Industry.— The wool and woollen industry has assumed a position which brings it to the front rank amongst the various industries of the world. According to the Board of Trade returns, the manufactured article stands fifth in importance amongst British industries at a value reaching 70 millions sterling, while the import of raw wool (apart from the home production) stands second amongst raw materials, touching the value of 35 millions sterling.

Germany, France, and Belgium are our principal competitors for the world's trade in woollen textile goods. The United States is actively engaged, and provides the vast bulk of its own requirements, for which it grows about 50 to 60 per cent of the raw material required. Austria, Italy, and Russia are entering into the arena in serious competition, while Japan is now making rapid initial developments. But the world is yearly making a larger call for wool goods. The increasing wealth and spending power of the community is all in favour of wool as against vegetable fibres for clothing.

Wool has therefore become an important commodity in the world's commerce. It is no longer a by-product of the sheep, the production of each country is now carefully and anxiously supervised, while its peculiar properties, its grades, and its values are being expertised to-day as never before.

Wool is grown in practically all countries outside the Tropics. It can be produced where the higher branches of agriculture and dairy farming are impossible, in fact in watching and forecasting production, it must be remembered that we are always dependent (and must be) on the poorest and most remote tracts of country for our wool supply. As soon as a country begins to be opened up and becomes available for cereals or dairy produce, the land becomes much too valuable for sheep grazing.

At present, Australasia comes a long way first and foremost both as regards the quantity and quality of its production. The 1909-10 Australian clip was a record one, and totalled about 2,130,000 bales, or about 816½ million lb. These wools taken all round are the best spinning wools in the world, and are used in every textile manufacturing centre for the best worsted and woollen goods.

Some years ago it was thought Australia had reached its limit because of two facts, both detrimental to production- one being *drought*, which at periods has killed off large numbers of its live stock, another being the fact that as a coun-

	Number of Sheep			Number in 18
EUROPE—				
Russia (1908)	61,549,000			
United Kingdom (1909)	31,841,000			
France (1906)	17,461,397			
Spain (1907)	16,119,051			
Italy (1905)	10,877,000			
Austria-Hungary (1900)	10,743,707			
Bulgaria (1905)	8,081,816			
Germany (1909)	6,700,000			
Roumania (1900)	5,655,444			
Servia (1905)	3,160,166			
Greece	2,900,000			
Sweden (1906)	1,051,119			
Norway (1900)	998,819			
Finland	937,565			
Denmark (1903)	876,830			
Netherlands (1904)	606,785			
Montenegro	195,000			
Crete	100,000			
Cyprus (1908)	301,669			
Belgium (1895)	235,772			
Switzerland (1906)	209,243			
Portugal	100,000			
Bosnia	94,717			
		181,396,100	.....	198,191,214
AUSTRALASIA		115,525,581		110,516,331
SOUTH AMERICA				
Argentine (1909)	62,211,754			
Uruguay (1905)	13 915,796			
Colombia	3,480,026			
Chile (1903)	1,335,332			
Falkland Islands (1908)	688,705			
Paraguay (1900)	214,060			
Venezuela	176,668			
Guatemala	77,600			
Bolivia	50,000			
Honduras	11,806			
		82,161,747		102,847 134
NORTH AMERICA				
United States (1909)	56,084,000			
Mexico (1902)	3,424 440			
Canada (1908)	2,818 780			
Newfoundland	78,052			
		62,405,262		57,158,600
AFRICA				
Cape of Good Hope (1908)	17,300,461			
Algeria (1907)	9,314,515			
Orange River Colony (1907)	8,020,308			
British East Africa (1908)	3,740,110			
Transvaal (1908)	2,811,061			
Natal (1908)	915,477			
Tunis (1902)	719 610			
Uganda	559,590			
Madagascar	364,083			
Southern Rhodesia (1908)	190,000			
		43,971,215		31,890,052
ASIA—				
British India (1908)	18,029,181			
Ceylon	100,603			
Japan	3,590			
		18,133,374		21,957,752
Grand totals		503,593,279		522,564,083

try begins to develop and to be opened up, its land becomes available for more lucrative purposes than for sheep grazing. But Nature is always romantic and full of surprises. The higher branches of agriculture have increased and flourished in New Zealand and Australia, but still the wool production has made sensational progress Nature appeared to have originally treated Australia rather badly. It left things in a topsy-turvy fashion The ocean bed is on the surface; the great rivers are underground, except in a few cases Some rise in a swamp and, after flowing for a few miles, disappear again, without source and without mouth.

But Nature is always inviting and compelling attack, and men are learning how to tackle her in Australia They can trace the water channels, and by following them, and by artesian borings, have procured wonderful supplies of water in districts that have previously been the most seriously affected by drought The drought spectre has been laid, and some of the desert places are becoming fertile. This is a factor that is going to alter reckonings in future, especially in the interior of Australia, and particularly in such colonies as Queensland, Western Australia, and South Australia. From Queensland in 1910 no less than 328,000 bales have been shipped, being

WORLD'S WOOL-USING POPULATION

	Present Population		Population in 1895	
EUROPE—				
Russia	152,009,000		127,000,000	
Germany	62,982,000		52,753,000	
Austria-Hungary	49,248,000		43,696,000	
United Kingdom	44,547,000		39,599,000	
France	39,267,000		38,518,000	
Italy	33,911,000		31,506,000	
Spain	19,794,000		18,238,000	
Belgium	7,239,000		6,496,000	
Roumania	6,684,000		5,710,000	
Netherlands	5,829,000		4,929,000	
Portugal	5,687,627		5,280,000	
Sweden	5,430,000		4,963,000	
Bulgaria	4,221,000		3,411,000	
Switzerland	3,555,000		3,151,000	
Servia	2,784,000		2,346,000	
Greece	2,680,403		2,434,000	
Denmark	2,659,000		2,306,000	
Norway	2,353,000		2,126,000	
Bosnia	1,750,000		1,600,000	
Crete	350,000		295,000	
Cyprus	258,997			
		455,233,027		396,387,000
AFRICA -				
Cape of Good Hope	2,507,500		580,000	
Algeria	5,231,850		500,000	
Tunis	2,000,000		10,000	
Transvaal	1,347,227		300,225	
Natal	1,206,386		64,000	
Rhodesia	697,000		-	
Orange River Colony	166,880		143,000	
Egypt	113,000		113,000	
		13,569,843		710,225
NORTH AMERICA				
United States	87,189,000		70,254,000	
Mexico	18,000,000		13,607,000	
Canada	6,945,000		4,834,000	
Newfoundland	250,000		200,000	
		112,384,000		88,895,000
SOUTH AMERICA				
Brazil	14,000,000		14,334,000	
Argentine	5,716,000		4,048,000	
Chile	3,874,000		3,009,000	
Peru	2,661,000		2,661,000	
Venezuela	2,602,492		2,075,000	
Uruguay	1,141,000		819,000	
Colombia	1,000,000		800,000	
Bolivia	750,000		500,000	
Paraguay	631,547		500,000	
Guatemala	100,000		85,000	
		32,302,839		28,867,000
ASIA (Wool-using)				
Japan	1,010,000		500,000	
India	100,000		97,000	
China	30,000		20,000	
		1,140,600		617,000
Miscellaneous				50,000
AUSTRALIA	4,396,325		3,183,000	
NEW ZEALAND	1,042,997		627,000	
		5,439,322		3,810,000
Grand totals		620,075,631		520,336,225

double the production of 1903–4. Western Australia has also doubled its production within the first decade of this century.

South America comes next with only 461,000 bales in 1910, and, owing to the 1909 drought, with a clip much below the average of the past decade. The bales are usually more than double the size and weight of the Australian bales, and in pounds the clip totals about 370 million lb. Important developments are being made in the extreme south of the New World, and the wool supply from Patagonia, Punta Arenas, and the Falkland Isles is becoming a valuable and important asset to the industry as a whole. These wools have remarkable and distinctive properties, the fibre being of a very light specific gravity, making it especially valuable for hosiery and finger-yarn purposes.

The South American peninsula is destined to become a potential factor, and an ever-increasing one, in determining the future and the value of wool. It produces an unequalled variety of qualities, and sensational advances are being made in some of the southern areas, unknown a few years ago, notably in the Patagonia and Punta Arenas districts.

If this were a historical paper there would be a romantic story to tell of pioneering work in

these areas and in the Falkland Islands. We don't hear much, because there are no government or interstate jealousies, no troubling, scenting politicians, and no Cecil Rhodes yet for that country—or we should be stirred by the story of how these bleak tracts of country are being settled. Suffice it to say that 60,000 bales of wool have been sent here in 1910, and that the production has been doubled in six years.

South Africa seems destined to rank high as a wool-producing country in the future. Since the Boer War, great improvement has taken place in the quality of these wools and in their preparation for market. Australian sheep have been bought for breeding purposes, and the Commonwealth Government has encouraged the industry by appointing inspectors to certify that clips have been properly classed and skirted. The 1909–10 clip totalled 377,000 bales, or about 130 million lb.

The United States raises about 300 million lb., which is required for its own industry, and owing to the high tariff duty on wool of 11 cents per lb. there is not much chance of its distribution in other countries.

Russia is the largest European wool producer, but its wool is not now exported, but consumed in its own country.

The supply from European countries is gradually diminishing, but the United Kingdom still produces about 140 million lb. annually. The United States is one of our best customers for our home-grown wools. Some interesting figures have been compiled by Messrs. Dalgety & Co. showing the chief sheep-growing countries of the world, and giving a comparison between the sheep flocks and the growth of population. The particulars are given on pp. 196, 197.

It will be seen at once that the wool production of the world is an enormous industry. Perhaps the most remarkable fact, however, is that the world is always ready and hungry for each clip. It is safe to say that during the past twenty years (probably it is true of a much longer period) there has never been at the end of the year an unsold surplusage of the year's production, despite cycles of bad trade or speculative movements, of more than 10 per cent., during the past two years (1909 and 1910) it has not averaged 2 per cent. Of course this does not always mean that the wool has been consumed,—it is not possible to determine what proportion of stocks are held in the manufacturing establishments of the world,—but it is enough to know that the consumer is prepared to carry the risks; it is never left on the market or in owners' hands, but is a commodity that is always saleable at a price.

Moreover, the demand for wool is so persistent and regular, that whatever class of wool (whether in good condition or otherwise) be produced it is absorbed; the preponderance of any particular quality may be a determining factor in values, but it does not apparently affect the demand and consumption. It could not be said that 'whatever is, is best', but it can be said of wool that 'whatever is, is used'.

The various properties and qualities of wools are dealt with in the preceding article, but it may be taken as a general fact that the bulk of wool (excepting very short-stapled sorts) is used for the worsted-cloth industry. *Worsteds* (made from combed wool) have come to be a permanent and predominating rival to woollen goods on account of their smartness and durability.

But wool is being more and more utilized for all sorts of textiles—from the finest ladies' cloths to imitation furs, sealskins, and astrakhan goods, and from hosiery, blankets, and khaki (army) cloths to tapestries, lace, dolls' hair, and teddy bears, and each article calls for and impresses a certain standard of value on the varied qualities of wool.

It is Nature that determines the production more than preferences of demand can do, although these latter may have some influence on values; but droughts and disease on one hand, or too much grass in good seasons, rendering the wool defective and faulty with vegetable matter, are always making a multiplicity of changes and developments in flocks; while the wonderful developments in interbreeding for producing various distinctive grades and qualities render the industry full of possibilities from both the utilitarian and money-making standpoints.

The increased output per head of sheep has been one of the most remarkable developments of recent years. The Australian farmer has during past years been trying by careful breeding to enlarge the producing capacity of each sheep. And if every sheep in Australasia (115½ millions) only gave ½ lb. more, it would mean a 200,000 bales increase. This is not only possible, but is an accomplished fact. In 1891, the record year for sheep, 124,991,920 sheep produced only 1,683,000 bales. In 1910, 115,525,581 sheep produced 2,434,643 bales. So that 9 millions less sheep produced 700,000 bales more. It is a sensational difference, and we have to alter all our theories about the decline of the wool production in certain areas. The increase has been gradual, but the average yield in 1909–10 works out at 7 lb. 4 oz. per head. In 1908–9 it was 6 lb. 14 oz. per head, in 1907–8 it was 6 lb. 9 oz. per head.

The dispute which raged for several years with regard to the Vermont breed was of course entirely attached to this question of increasing the weight of the fleece from each sheep, but in that case it appears to have involved too great a sacrifice of quality and value, and fine-wool consumers have objected in every branch of the industry.

Of course, in rich agricultural and dairy-farming districts, as in New Zealand, the heavy Lincoln breed of sheep can be kept, which produce both a valuable carcass for mutton, and the long cross-bred wools. Naturally, wherever possible, farmers in Australasia and South America have endeavoured to develop the mutton trade, and the result is that up to 1905 there was a steady and large increase in the proportion of cross-bred and coarser-grade wools which were being produced. This was especially noticeable in New Zealand and South America. Consequently, in 1902–4 the total production in these two largest wool countries showed over 51 per cent. of cross-

bred grades Thanks, however, to good seasons in the poorer countries of South Africa, Western Australia, and Queensland, the proportion has been steadily declining, and in the last year's (1909–10) clip it showed only 42·8 per cent of cross-breds as against Merino.

The most satisfactory feature of this increase in merino production is the fact that the districts named which are showing the increasing production are all practically free from the spinal burr, which is such a serious depreciating factor in the Victoria and New South Wales districts.

[H. D.]

Wool Industry in Australasia.—The history of sheep in Australia dates back to the first settlement in 1788, but the wool industry cannot be said to go back that far, for the sheep which came with the first fleet were destined for the dinner table and not for wool production. The first sheep census of Australia, dated May 1, 1788, shows 29 sheep out of some 70 purchased at the Cape on the way out. In September of the same year a return shows that only one sheep remained. Each vessel which followed, however, picked up mutton sheep at the Cape, and the first sheep-breeding experiment ever made in Australia was in crossing some of these Cape rams with Bengal ewes. The lambs produced were said to be as large as the old ewes in six weeks, but the wool was of a mongrel description.

The first man to see the possibilities of fine wool production in Australia was Captain John Macarthur. Attached to the 102nd Regiment, he landed in Australia in 1790, and in 1793, obtaining a grant of land, started farming. His first flock consisted of 50 Bengal ewes, and 6 or 7 rams of mixed English and Spanish descent. The Rev. Samuel Marsden, a contemporary pioneer, commenced operations in 1796, but aimed more at a general-purpose sheep than at the reproduction of fine wool.

Practically the Australian wool industry began in 1797 by the importation of the Gordon Merinos. The honour of bringing these Merinos to Australia is due to Captain Waterhouse of the 'Reliance' and Captain Kent of the 'Supply.' These vessels were sent to the Cape for supplies in 1797, and while there an opportunity occurred to purchase some pure Merino sheep. One authority says that Macarthur had asked the captains to purchase any fine-wool sheep that offered, and this is more than probable. The Spanish king had, some time before that, presented to the Dutch Government some pure Merino sheep of the Escurial flocks. They were sent to the Dutch colony under the charge of Colonel Gordon, who died there. There is nothing to show how Colonel Gordon became possessed of the sheep, but he seems to have done so, and on his death his widow dispersed the flock, which then numbered 32. Three she gave to Governor King, and three to a Colonel Patterson. The remainder were offered to the Commissary who was at the Cape to purchase cattle for the Settlement. He declined to purchase, and they were offered to Captain Waterhouse. The captain could not afford to finance the whole purchase, but Captain Kent, so that they might not be lost to the Settlement, agreed to purchase half. They each took 13 (starting Australia's wool industry with an unlucky number), and in addition Governor King's three also went on the 'Reliance' the three given to Colonel Patterson went to England. Mrs Gordon was paid £4 per head, and the expense on delivery was about £1 per head more.

As to how many of these actually arrived in Australia there is some uncertainty. A letter written years after by Captain Waterhouse to Sir Joseph Banks says, 'I do not remember the number I had alive when I arrived at Port Jackson, but I think more than half.' Captain Kent, who, I understand, shared his with Colonel Braithwaite, I believe lost all, from the circumstance of his applying to me for one immediately on his arrival.' Another authority says that Captain Kent had one ram left when he reached Australia. As to the distribution of these historic sheep, Captain Waterhouse says in the letter already referred to: 'I offered all mine to the Governor, but he was satisfied as they were in the colony and declined purchasing them. Captain Macarthur then offered me 15 guineas per head providing I let him have the whole. This I declined, wishing to distribute them. I supplied Captain Kent, Captain Macarthur, Captain Rouley, and the Rev. Samuel Marsden. As the Spanish ewes had lambed not but Spanish rams running with them—I supplied Mr. Williamson, Mr. Moore, the Government, and, in fact, any person who wished to have them.'

This was really the birth of the Australian wool industry, and unquestionably it was Captain John Macarthur who proved the possibilities of Australia as a wool-producing country. In 1800 he forwarded eight samples of wool to England addressed to Sir Joseph Banks, and in 1803 a report on these samples was published. A ewe's fleece was valued at 4*s* per lb, a ram's fleece at 5*s* per lb. Other fleeces showed the type of wool on the Bengal sheep. Of this the experts said: 'Bengal ewe hair only fit for bricklayers to mix amongst mortar to build their houses with in the colony.' In the Sydney Technological Museum are preserved samples of wool grown by the Rev. Samuel Marsden which were submitted to Governor King in 1801 for his information as to the suitableness of Australia as a wool-producing country. Macarthur in 1801 was able to double his flock by purchasing that of Major Foveaux on that gentleman's leaving Australia. In 1803 he had 4000 sheep, and was thus the first 'sheep king' of Australia. Macarthur, as a result of a duel with a fellow officer in 1803, was ordered to England, and to this circumstance Australia owes her first advertisement as a wool-producing country. He took home with him samples of wool from the Gordon Merinos, and gave evidence before a Commission. He endeavoured to form a company to exploit the fine-wool industry in Australia. He declared the climate to be favourable to fine-wool production, although scientists had expressed the opinion that the wool in such a hot country would rapidly degenerate into hair. He stated that in 1801 the heaviest fleece shorn was 3½ lb, while in 1802 the average weight was

5 lb and the wool finer and softer The fleece of one of the Cape Merinos was valued at 4*s* 6*d* per lb, and that of a Parramatta-bred Merino at 6*s* per lb.

The second important lot of sheep to be imported to Australia were those purchased by Macarthur in 1804 from the stud flock of King George III. At this time the Spaniards, desirous of keeping the lucrative business of wool-growing to themselves, had made it a capital crime to export sheep from Spain. A few had, however, been given to King George III, and after bringing the flock at Kew up to substantial proportions His Majesty decided to hold an auction sale of surplus stock, so as to secure the placing of the sheep in the hands of those who would most highly value it and attend to the increasing of the breed

Macarthur purchased 7 rams at prices from £6, 15*s* to £28, 7*s*, the fleeces weighing from 3 lb 4 oz to 7 lb 2 oz. He also purchased one ewe at 11 gs As the industry grew Macarthur became the first stud-breeder of Australia, and *practically laid the foundation of the pastoral greatness of Australia*, and the Camden Park sheep were the origin of many of the fine wool flocks not only of the Mother State, but of Australasia

The first shipment of Australian wool was one bale sent by Captain Macarthur to England in 1808 by the 'Dart' The weight was 245 lb, and the wool realized 10*s* 1*d* per lb The following figures give the imports of colonial wool into the United Kingdom since then

Year	Bales
1808	1
1810	98
1820	422
1830	8,004
1840	44,502
1850	158,558
1860	240,136
1870	673,314
1880	1,054,430
1890	1,509,666
1895	1,802,269
1900	1,221,163
1905	1,327,167
1906	1,319,636
1907	1,624,997
1908	1,635,296
1909	1,761,108

The progress of sheep in Australia in the early days is shown in the following comparisons —

Year	Sheep
1788	29
1792	105
1794	526
1796	1,531
1797	3,902
1798	10,057
1799	4,721
1800	6,124
1801	6,757
1803	11,232
1804	12,675
1805	19,359
1810	33,818
1813	65,121
1814	74,825
1815	62,476
1816	55,997
1817	170,920
1818	172,340
1819	156,740
1820	156,302
1821	138,755
1822	177,985
1823	184,836
1824	237,622
1825	205,800

Latter-day progress is shown in the following comparison —

Year	Sheep
1861	23,741,706
1871	49,773,584
1881	78,063,426
1891	124,547,937
1901	92,441,835
1905	93,534,579
1906	103,796,126
1907	108,473,622
1908	109,345,967

Exports of wool from Australia during the period 1807-1909 were

Year	lb
1807	245
1808	562
1811	167
1815	32,971
1816	75,171
1817	13,616
1818	86,525
1819	74,284
1820	99,415
1821	175,153
1822	172,880
1823	198,240
1824	275,560
1825	411,600
1826	1,106,302
1827	512,758
1828	1,574,186
1829	1,838,642
1830	1,967,279
1831	2,541,205
1832	2,377,057
1833	3,516,869
1834	3,558,091
1835	4,210,861
1836	4,996,645
1837	7,060,525
1838	7,837,423
1839	10,128,774
1840	9,721,243
1841	12,399,090
1842	12,959,671
1843	17,433,780
1844	17,589,712
1845	24,150,687
1846	21,836,270
1861	88,087,600
1871	257,605,800
1881	393,341,700
1891	661,229,300
1901	673,914,300
1905	671,944,000
1907-8	686,818,010
1908-9	756,590,163

Early Australian wools were sold at Garraway's Coffee House, Cornhill. The earliest record available is of a sale in 1820, when 58 bales were offered, and the wool made an average of 3*s*. 7*d* per lb, the best bringing 5*s*. per lb. A catalogue is preserved of a sale of 329 bales of Australian wool at Garraway's on August 17,

1821 Macarthur's J M'A brand was represented by 26 lots, selling up to 10*s* 4*d*. per lb., that price being paid for a one-bale lot. A two-bale lot made 5*s*. 6*d* per lb, 3 bales 3*s*. 10*d*, 2 bales 3*s* 7*d*, 1 bale 3*s* 7*d*, 1 bale 3*s* 6*d*, 2 bales 3*s* 6*d*, 3 bales 3*s*. 5*d*., two lots of 2 bales 3*s* 3*d*., and others down to 2*s* 5*d* The J R W. wool (John Riley Wattle) came next, 49 bales selling from 1*s* 1*d*. to 1*s* 9*d*. per lb Mr. Hannibal Macarthur sold 11 bales up to 2*s*. 5*d*. For many years the J M'A wool occupied premier position and brought top prices The record price for Australian wool which will probably last for all time was 16*s*. 4*d*. per lb, obtained for a line of Macarthur's J. M'A. wool in 1827 The Sydney Gazette of May 18, 1827, says 'Though Mr Macarthur and the Sydney Gazette are not likely to be upon terms of regard, still we congratulate the old gentleman upon some of his wool bringing in London so high a price as 16*s* 4*d* per lb'

The enormous value of the wool industry to Australia is shown in the following comparison going back to 1861

Year	Value
1861	£5 629,449
1871	13,488,880
1881	16,136,082
1891	24,063,227
1896	20,433,855
1901	18,036,557
1902	16,109,026
1903	18,042,873
1904	21,796,096
1905	27,203,549
1906	29,111,424
1907	35,267,851
1908	28,244,993

The value of the wool sold in Australasia each season since 1898-9 is as follows

Year	Value
1898-9	£8,730,525
1899 1900	13,503,594
1900 1	6,176,083
1901-2	8,708,587
1902 3	8,810,840
1903 4	10,046,656
1904 5	13,825,269
1905-6	18,304,012
1906-7	21,835,131
1907-8	17,577,249
1908-9	18,805,529

Note — The wool is practically all sold for export to manufacturers in various parts of the world

High Price for Wool - In 1889 some washed combing wool of the 'Ercildoune' clip, grown in the Western District of Victoria, realized 5*s* ½*d* per lb, = £56, 11*s* per bale.

Wool selling in Australasia — When Australia first came into prominence as a wool producing country there was no thought that the time would ever arrive when the bulk of the wool grown would be sold to direct representatives of the world's wool users prior to shipment The whole object in view was to produce the type of fine wool required by the home manufacturer, which experience had demonstrated could be grown to perfection in Australia. At the birth of the Australian wool industry there was no thought of catering for the Continental or American demand All these countries had large flocks of their own, producing sufficient wool for their requirements, and it was to feed the British manufacturer that the founders of the staple industry of Australia had in view as their great objective As wool-using machinery was improved a larger output was rendered possible, and happily the strides in mechanical science kept pace with the development in the production of the raw material in Australia Regular auctions for the sale of Australian wool were instituted in London in 1835, although for some years prior to that date the wool was sold at auction in London at irregular intervals, and records are in existence of such sales as far back as 1821 At first the English user was the only customer, but gradually, as the Continental flocks diminished, representatives of foreign countries appeared in the English market

In Australia in the very early days all the wool was shipped for sale in London No other course was possible. This naturally meant a very long and anxious wait on the part of the squatter. First, the slow journey by bullock dray to the seaboard, taking weeks, and even months; next, the long trip to England in a sailing vessel, and the further long wait until the returns came to hand The need of ready money or supplies to carry on with, forced the smaller growers to seek advances from merchants The merchants were willing to advance on the wool by loading the returning teams with supplies, but wool was found to be such a convenient means of exchange that merchants gradually adopted the practice of purchasing small lines of wool for shipment in payment of goods received Only the smaller growers were disposed to sell right out, as large owners realized that the price bid in Sydney, Melbourne, or Geelong was in the nature of a speculation, and that the purchasers very frequently made very large profits in the wool they shipped. Gradually the competition became very keen among the merchants for these wools, and the early wool buyer appeared on the scene. Generally he was a man who had had experience in the mills of Yorkshire, and could bring expert knowledge to bear on the work of fixing the value of wool Some of these early buyers were, indeed, highly skilled men Their business was to interview the small owners on their arrival in town, and bargain with them for the purchase of their wool Their occupation was at first an easy one, for the wool only came to hand at very irregular intervals, but as competition increased, the work became more strenuous The buyer had to be ever on the alert for stray lines of wool, and was frequently called upon to go out along the roads to meet the incoming teams and bargain for the wool, or to haunt the wharves for wool arriving by boat At irregular intervals, odd lines of wool were offered at auction at sales of goods and furniture by the regular auctioneer. In New South Wales Thomas Sutcliffe Mort is regarded as the founder of the industry, for, starting in 1843 as a general auctioneer, he soon inaugurated regular sales of wool and station produce, properties, &c. That

was practically the start of the wool-selling industry in Sydney. Later on, other firms started, and gradually the business assumed important proportions. It was, however, in Melbourne that the biggest strides were made in the early days, due to the energy and ability of Richard Goldsbrough, a Yorkshireman, who prior to his arrival in Melbourne had served an apprenticeship in a Bradford woollen mill. The southern centre, inaugurated in 1848, soon became the leading mart of Australia, and even attracted large quantities of wool from Sydney.

The Australian sales were at the start dependent almost entirely upon the buyer representing the various merchants and on the speculative element. Gradually, however, buyers came from the Old World, but it was not until the Continental wool user adopted the progressive policy of being directly represented at the Australian sales that the possibilities of the wool-selling industry were seen in their full magnitude. The various phases of the development which has taken place are full of historic interest, and each is worthy of a detailed account.

The story of the rise and progress of the wool selling industry affords one of the most striking illustrations of successful commercial endeavour that can be pointed to in the history of modern times. The start was a modest one, and the facilities were of the most primitive description. The pioneers of the industry had an uphill battle to fight, and to those captains of industry like Mort and Goldsbrough, who set out in the face of strong prejudice to build up the colonial markets, Australia owes much. The London market, firmly established, had great attractions for the squatter, and the London selling brokers had little doubt but that the policy of selling in Australia was only 'a flash in the pan' and would not last. It was urged that the existence of dual markets was prejudicial to wool values, and the local sales for years only appealed to the smaller grower, to whom prompt realization was absolutely essential. It can even be said that it was the smaller growers who made the colonial markets. The larger owners, finding that the selectors were realizing prices locally which were fully equivalent to London parity, gradually gave their support to the local sales, which began to swell very considerably in volume.

The great success of modern times may be ascribed to the development of the policy of closer settlement on the one hand, and the large increase in the army of English and Continental buyers on the other hand, who regularly visited the colonial sales, and as the business expanded, established their permanent offices in Australian centres.

The Pioneering Wool Buyer.—Paradoxical as the statement may appear on the surface, it was really the wool buyer who pioneered the Australian wool-selling industry. Wool buyers were known in Australia long before wool-selling brokers. In fact, the wool buyer actually created the market, and the wool-selling broker was evolved in the natural order of things. Pioneer wool buyers operating on behalf of the local merchants plied their calling long before there was any idea of establishing a regular system of wool auctions. The demand for wool for exchange purposes by the merchants led to their engaging men who by their experience in Yorkshire mills were qualified to buy wool, and some of the larger merchants even imported specially qualified men to act as their wool buyers. The methods of the early buyers were vastly different to the system of to-day. No facilities of any description were provided. The wool teams put up at some of the old inns on Brickfield Hill, Sydney, and while the teamster was taking his bullocks to a waterhole near the present Belmore markets, the buyer would clamber on to the loads of wool and begin his inspection. No specially designed show floor and elegant saleroom were provided. The light of day and the canopy of heaven were all the wool buyer required. He would cut a slit in a bale, withdraw a handful of wool, and on that handful base his estimate of value. Then would follow a haggling match with the owner. Probably the buyer and the owner would adjourn to tea together, play cards, drink, smoke, and yarn all the evening, and perhaps not till the next day would the bargain be made.

The determination of values in those days was a difficult matter. The wool was worth whatever the buyer could be induced to pay, and both buyer and seller were absolutely in the dark as to what was the actual ruling value in the Old World. Ocean cables were unheard of, and vessels took many months in coming from England, and arrived at irregular intervals, so that there was always a large element of speculation in buying wool. The rough-and-ready arrangement in the early days, which was always understood by the buyer and seller, was that a price per pound had to be fixed for fleece wool, and the bellies and locks were taken at half price. The quantities available were very moderate, as all the larger owners shipped to London, and only the selectors, pressed for ready cash or supplies, could be induced to sell locally. A line of ten or fifteen bales was regarded as a very satisfactory purchase. Naturally, as the demand among the merchants was great and the available quantities limited, there arose a keen competition, which in a measure protected the interests of owners. Speculation began to take a hand in the business, which increased the competition. Part of the equipment of the early buyer was a swift pony, on which he could canter off to the wool scour on the outskirts of the town to secure a few bales, or go out along the main road to meet incoming teams and bargain for the wool. Having received advice that an owner was coming down to Sydney with his wool, the buyer would go out daily in the hopes of meeting the owner and forestalling other buyers. One of the earliest of Sydney buyers, Mr. P. B. Whitfield, has left some interesting reminiscences on this point. In passing, it may be noted that Mr. Whitfield came to Sydney acting for Mr. Alexander, who had married the widow of Dr. Redfern, to whom the Redfern estate belonged. It was his business to manage the estate, sell the land in blocks as opportunity offered, invest the pro-

ceeds in wool, and ship it to England. Many of the men who purchased the land only after great persuasion, found it a most profitable investment in after-years. Referring to the purchase of wool in the early days, Mr. Whitfield in his reminiscences says 'Many an hour have I waited, either alone or in company with another buyer, when I had guessed that any wool would be coming down, listening for the creaking of the wagons. It was tedious waiting, but when the wool was in sight we used to go to work at once, cut a slash in the bale, take a handful of the wool out, and look at it, then put it back, and do the same with another bale. The owner would look on all the time and pretend to be indifferent. Then I would make him an offer. 'Oh, no,' the owner would probably say, 'it is worth more than that now,' when perhaps he had been away the whole year in the bush and knew nothing at all about it. He would pretend to start his wagon again, keeping a sharp eye on us to see if we would advance. If the owner really thought that the wool was worth more, he would refuse our offers and take the wool to the hotel or send it to the merchants for sale or shipment. In this way they used to get a fair price for their wool. The buyers were all so eager to secure parcels that it was just the same as an auction. Sometimes, I admit, we resorted to a little manœuvring to get the wool, and would make an offer a little under the mark, and, refusing to advance, the buyer would ride back without doing any business. He would meet another buyer and say 'Old So-and-so is coming down the road with his wool. I offered him 6*d* for it. If you go a farthing more you will get it.' The owner thinking now (and perhaps correctly) that he had got the full market value for his wool, a bargain would be struck, and the wool coming to town would be delivered to its new owner.'

A contemporary buyer, Mr. James Johnson, in his reminiscences published some years ago, said 'How did I buy my wool in the early days before there was any regular market? I used to take my horse and ride along the Liverpool road to the Bark Huts, and wait there. I should, if fortunate, meet a load of wool drawn by bullocks, the owner driving. I would get into conversation with the owner and look at the wool, and presently make him an offer for it. After a good deal of argument we would very likely strike a bargain. If not, he would take the wool to the Haymarket and take his wool into the yard of one of the old Brickfield Inns, where some other buyer would make a bargain with him for it.' Mr. Johnson was a scourer and speculator who started in a modest way, and had a very long experience. The ultimate success of his operations may be gauged by the fact that at his death he left an estate valued for purposes of probate duty at £214,718. Other early buyers were engaged by the merchants at a weekly wage, and one who was operating for many years was in the receipt of 10*s* 6*d* per day, which was regarded as a princely wage at that time.

The early buyers were useful to the small owners, who required an immediate sale of their wool, and their operations, although small in comparison with modern times, paved the way for the foundation of the wool-selling industry. By the time auction sales were *inaugurated* there were quite a number of buyers and speculators in wool, and they and the owners were ready for the innovation of wool sales. Buyers welcomed the opportunity of being able to attend sales and bid for whatever quantity might be available, and owners appreciated the means provided of having the full competition of all the buyers, thus enabling them to secure full market value without the old-time haggling with buyers.

The Birth of Wool Auctions.—Eventually odd parcels of wool found their way to the rooms of the old-time general auctioneers. They would only consist of a few bales—perhaps only one or two bales, or even a dozen—and they were sold under the same conditions as furniture, groceries, clothing, &c. Auction selling of all classes of goods was a great institution in the early days of Sydney, and large quantities of goods were disposed of in this manner. The wool offered at auction was sold without trouble, and it was from these odd sales that the idea germinated of holding regular auction sales of wool in Sydney. The beginning of things in Melbourne was different. There the 'father' of the selling industry, Mr. Goldsbrough, set out to establish a wool-selling business as a branch of his stock and station agency, and, bringing modern methods to bear, achieved a wonderful success. In Sydney the start was some years earlier. The first man to make a feature of selling wool at auction was undoubtedly Mr. T. S. Mort. He started in business as a general auctioneer in 1843, and as assigned estates were plentiful at that time, following on the great collapse of the industrial fabric, there was no lack of business. A fair proportion of wool came his way for sale, and as the quantity increased it was found possible to hold regular sales of wool and produce. Absolutely no facilities were provided for the trade. The first wool store in Sydney was an old dilapidated shed erected on the banks of the Tank Stream, then a rivulet of some consequence—somewhere near where Angel Lane now is. An old-time authority referring to this store says 'In the 'forties there were no wool brokers except Mr. Mort, who had a very primitive place with an iron roof, without walls or gate, under which the wool, sheepskins, hides, and what not used to lie. In this structure there was a weighing and dumping apparatus where the wool was weighed and pressed, and sent on board ship when the tide and mud allowed. That was about all the conveniences the wool trade in those days possessed.'

Mr. G. F. Dixon, in the reminiscences he left, referred to Mr. Mort's first attempt to hold wool sales. He says 'He made a start for himself in Pitt Street, near Angel Lane, but soon found his place too small, and moved near to where the Post Office now is. It was just about where Paling's music store is now located. There was an opening through from

George Street across the Tank Stream Later on he moved down to Circular Quay, where he started in a single-storied building at first Mr Dixon arrived in Sydney in 1842, the year before Mr Mort started in business. He had previously served his apprenticeship to wool sorting in Leeds, with a view to becoming a wool manufacturer. For this he had to pay a premium of £160, and work for seven years without remuneration. When his apprenticeship was finished, it was found that it would require £10,000 capital to start, and as this amount was not forthcoming he came out to Australia. He secured an engagement as wool buyer for Messrs. Campbell & Co., and later on acted in a similar capacity for Messrs Gilchrist & Alexander. He gives a definite idea of the business done at the early auctions. 'For a long time after the sales were started', he says, 'it was the exception rather than the rule to sell at auction I don't believe there were more than 3000 bales sold by auction in a season' Mr Dixon goes on to say that in the early days the wool was all washed on the sheep's back They thought anyone mad who spoke about selling wool in the grease At length, however, one or two tried it with success, and then all the sheep-owners with one accord went in for it, the reason being that the buyers for a season or two did not make sufficient allowance for the loss in weight by scouring, and paid too much for the wool, many of them 'burning their fingers' over it The squatters knew roughly what they had been getting for the fleece of each sheep, and when they got so much more they jumped to the conclusion that it would pay them better to sell in the grease It certainly paid them very much better until the London buyers learned to make proper allowance for the loss in scouring Mr Dixon refers to an incident at one of Mr Mort's early sales 'I was a little late,' he says, 'and just as I got near I heard my name mentioned, and when I went in Mr Mort said 'Are those your returns that I see in the Herald to-day?' I answered 'Yes', and he said 'Well, they ought to have paid the other halfpenny and made it an even half-crown' The mail had just come in, and my returns of 2*s* 5½*d* for washed fleece had been published in that morning's paper' Mr. Dixon refers to wool-washing being carried on in the Tank Stream. He also recollected when he and Mr Henry Parkes (afterwards Sir Henry) were working together at the Quay Parkes was casually employed by the Customs House at 5*s* a day, and Dixon as a wool buyer received 10*s*. 6*d*. a day regularly Among early buyers mentioned were Messrs Edward Bennett, Buttery, Blakey, Atkinson, Ebsworth, Bray, Jackson, and Whitfield

As the wool-selling business increased, regular weekly sales of wool were held An authentic account of a wool sale in Sydney in 1859 was given some years ago by Mr Henry Austin, a veteran wool buyer, who first landed in Sydney in October, 1858. He was engaged as a wool buyer for Messrs. J. T. Armitage & Co. of Sydney, but in those days Melbourne was the most progressive wool-selling centre, and he had to go to Melbourne to buy wool. He mentions that at that time the principal buyers in Melbourne were John Sanderson (Sanderson & Murray, Galashiels), Ryder (one of the oldest Australian buyers), and Prince, Ogg & Co There were two wool-selling firms in Melbourne, viz. Richard Goldsbrough & Co and J. H Clough & Co. Both firms had stores far ahead of anything in Sydney, stone-built and spacious, and the methods of doing business were far more up to date than Sydney. They had printed catalogues at the sales, the wool was displayed for sale in well-lighted showrooms, and business was done in a correct, methodical manner, vastly different to the happy-go-lucky style then prevailing in Sydney. Mr Austin regards Mr. Richard Goldsbrough as the founder of wool-selling in Australia, and from his personal experience of him describes him as being a generous, open handed, energetic Yorkshireman, and in his day one of the most popular men in Melbourne Mr Austin says 'To the best of my belief Mort & Co. were the only firm selling by auction in Sydney in 1859, and they, I fancy, took but little interest in the business, sales of big estates and properties having naturally greater attraction than the handling of the few bales intended for local realization. Practically the wool business was in the hands of large mercantile firms, such as D Cooper & Co, Gilchrist, Watt & Co, Campbell & Co, Flower, Salting & Co, and others who, as soon as the wool made its appearance in town, lost no time in putting it on board ship, advancing on it, and sending supplies to the various stations by the returning teams In these circumstances one could hardly have looked for an imposing catalogue at a Sydney wool sale, but I certainly was not prepared for the impression I was to carry away with me at my first attendance A weekly wool sale took place every Thursday, and was held in a shabby, low, two-storied building on the Quay Half past eleven was the hour for the auctioneer, Mr O B Ebsworth, to make his appearance. Prior to his arrival a few buyers (Messrs Kummerer, Hinchcliff, Johnson, Whitfield, and Hirst) might be seen arriving one by one to inspect the wool for sale The storeman, old Lewis, would cut open the bales with a formidable-looking knife, and a wretched untidy-looking catalogue was handed to each buyer as he turned up. A man stood outside the door with a bell to proclaim to all and sundry that a wool sale was to take place, for all the world like a secondhand furniture sale of to-day. A bale of washed wool (greasy wool was almost unknown then) was pulled down to serve as a rostrum for the auctioneer, who, after various greetings with buyers and communings with Lewis, the storeman, took his place on the bale, and began to read the conditions of sale If, when a lot was put up, any bidder thought he had not had time enough to examine it properly, he would call upon the auctioneer to wait a bit and give him time to make a further examination Nothing loath, the auctioneer rarely refused to grant such a request, which was never objected to by anyone present, time, of course,

being no object Bids were made by nods, winks, upliftmg of pencils, &c, vocal bids being in the minority. In a word,' sums up this veteran buyer, 'anything more unbusinesslike, shabby, and contemptible than a Sydney wool sale in 1859 it has not been my misfortune to attend. The redeeming feature was the old Irishman Lewis, who could always raise a laugh when he set his tongue wagging in the richest of brogues Little did I think when I left that sale that I should live to see Sydney the great Australian wool market that it is to-day ' From 1859 to 1863 Mr Austin as a buyer had to spend the best part of the summer in Victoria attending the Melbourne sales.

In 1864 Messrs Mort & Co made an application to the Exchange to hold weekly sales in that building on the Thursday of each week The application was granted and a new system of selling inaugurated. By this time Mort & Co had ceased to be the only wool-selling firm, and a wool roster for 1869, ten years after the sale described above, shows that the firms selling at the Exchange were Richardson & Wrench, Irwin & Turner, J Devlin, junr , Brewster & Tiel ck, O B Ebsworth, and Harrison & Jones

The Founder of the Sydney Sales - By common consent Mr Thomas Sutcliffe Mort is regarded as the founder of the wool-selling industry in New South Wales He may not have been the first auctioneer to actually sell lines of wool at auction, as has already been explained, but he was undoubtedly the first man to originate regular sales of wool and skins, and lived to see the wool-selling industry reach proportions of importance

Mr. Mort was born on December 23, 1816, in Bolton, Lancashire, England He received the ordinary commercial education, and on leaving school entered the country house of a big firm of warehousemen in Manchester. When he was about twenty-three years of age the firm with which he was connected received an application from Messrs Aspinall, Brown & Co. of Sydney for a capable clerk, and his name was suggested for the vacancy. Being fired with ambition, and only too anxious to carve out a future for himself in a young country, he gladly accepted the offer and made arrangements to come to Australia. He arrived in Sydney in 1838, and at once entered upon his duties, and from the outset displayed marked ability. At the time the firm of Aspinall, Brown & Co. were located in an unimposing wooden building in Charlotte Place, and here Mort was called upon to fill the dual position of clerk and salesman He remained in the employ of this firm and of its successor, Gosling, Brown & Co., for about five years. In 1841 he married Miss Theresa Laidley, eldest daughter of John Laidley, at one time Deputy Commissary General In 1843 his firm was involved in the general financial collapse which took place. This disaster, which affected many of the leading houses of the day, was owing to an indiscriminate rage for speculation which prevailed about that period, and the stoppage of the sale of land consequent upon the price being raised from 12*s* to 20*s*. per acre. Great facilities had been given by the new banking and loan institutions for obtaining the use of money, a mania for purchasing cattle and sheep had swept the colony of most of its available capital a few months before, and English exporters were willing to give enormous credit to secure the sale of their commodities A feeling of false prosperity had carried the hitherto successful ones into excesses of wild extravagance and expense, and when the crisis came the bubble burst without a note of warning The Bank of Australia was the first to fail, and, as it was then the leading institution of its kind, it involved most of the leading houses of the day in its downfall

It was at this critical period that Mr. Mort launched out for himself as a general auctioneer The announcement of his start is found in the Sydney Morning Herald of Tuesday, Sept. 5, 1843, and subsequent issues, viz —

NOTICE

Mr. T. S. Mort begs to announce his intention of commencing business forthwith as an auctioneer and broker

In the absence of more eligible premises he has temporarily taken those adjoining Messrs Levick & Younger, George Street, and immediately opposite the Bank of Australasia, where he requests his friends will kindly forward their communications.

His terms and mode of business may be learned on application at his office

George Street,
September 3rd, 1843.

Mr Mort lost no time in getting to work, and appears to have sprung into the front rank as an auctioneer straight away His first general sale was on Monday, September 11, 1843, when he offered a variety of goods, and he conducted two other auction sales the same week The first occasion upon which he sold wool was on September 15, 1843, and the advertisement of this sale reads —

WOOL

Mr T S Mort will sell by auction this day, Friday, September 15th, at his temporary rooms opposite the Bank of Australasia, at 11 o'clock,

2 bales of wool.

Terms at sale

Slowly but steadily the business increased Mr. Mort secured new rooms in George Street 'four doors north of the General Post Office', and in January, 1844, he offered a catalogue set out as follows —

15	bales	washed	wool
7	,,	,,	,,
3	,,	,,	,,
5	,,	,,	,,

Presumably each lot was from a different owner, but no brands are given in the advertisement. The concluding item of this sale was a consignment of half a ton of 'British-caught whalebone'.

Mr. Mort's success from the start was most pronounced, and was due to his great ability as an auctioneer, his taking manner, and his

untiring energy. In the early days of his business he withdrew himself entirely from society (and Sydney was a pleasure-loving place then as always) and devoted all his energies to his new avocation, working for a long time at the rate of fifteen to eighteen hours a day. It is characteristic of the man that so great was his love of gardening that, despite the long hours he was working, he would, on his return home, devote many a half-hour by candlelight to beautifying a small plot of garden ground in front of his cottage at Double Bay.

For some years Mr Mort developed the wool-selling business, and established an organized system of public wool sales in Sydney. The squatter on his far-away station had hitherto only found a very precarious market in Australia, and was now enabled to count on a safe outlet for his wool and a much quicker return than was involved in shipping to London. As the wool business expanded, Mr Mort handed over the actual control to assistants and threw his energies into other channels of development. The late Mr O. B. Ebsworth was his wool auctioneer for many years, and subsequently started in business for himself as a wool-selling broker. For some years Mr Mort was in partnership with Mr Brown, and the style of the firm was Mort & Brown; later on, it was changed back to Mort & Co. Among those who were associated with the firm in the early days were Messrs. E. W. Cameron, Benjamin Buchanan, Henry Mort (brother of T. S. Mort), Ludley Mort (son), and Mr. Joseph Abbott.

Mr Mort was foremost in all the great commercial enterprises of his day, and was a power for good. Modest and unassuming, he was public spirited and full of energy. His views were large and liberal, his enterprise courageous, and he had unbounded faith in the future of his adopted country. His commercial record is pure and unsullied, and he, by his many enterprises, did much to develop and open up the resources and capabilities of the colony. He was one of the promoters of the first railway from Sydney to Parramatta, and every progressive move had his hearty support. At the time of the gold discoveries at Ophir in 1851 he formed the first company for working auriferous lands, under the title of the Great Nugget Vein Mining Co. When the shareholders of this company grumbled at the delay in securing fortunes, Mr Mort called them together and offered to buy up the whole of their interests, with the result that they changed their opinions quickly and lived to be thankful for doing so.

In 1856 Mr Mort joined Mr. Hawkins and purchased 14,000 ac. of land at Bodalla. He spent £100,000 on the property, buying his partner's share in 1860. Later on he was identified with the silk, cotton, and sugar industries, spending £20,000 on the last named, founded Mort's Dock, formed several copper and mining companies, identified himself with the coal industry, and was one of the founders of the Australian Mutual Provident Society. His last years were devoted to endeavouring to perfect the frozen-meat export trade. He died at Bodalla on May 9, 1878, in his sixty-third year. During the forty years he was in Australia Mr Mort did more to develop its resources than anyone had previously done, and his memory is honoured as the founder of quite a number of industries apart from wool. Shortly after his death a public meeting was held in Sydney, and it was decided to fittingly perpetuate the memory of one who had done so much for his adopted country. The statue in Macquarie Place, which is in bronze and by Conolly of Florence, is the result.

The Founder of the Melbourne Wool Market

Mr. Richard Goldsbrough has been described as the 'father' of wool-selling Australia, and although Mr Mort's start in Sydney preceded that of Mr Goldsbrough, it was undoubtedly the latter gentleman who brought the Australian wool market into prominence in the early days by providing up-to-date facilities and carrying on the business in a thoroughly systematic manner. Richard Goldsbrough was a Yorkshireman, and prior to coming to Australia had served an apprenticeship in a woollen mill at Bradford, for which he had to pay a high premium. He, however, went through the business thoroughly, and the information he acquired stood to him well in after-years. He was well versed also in the methods of showing and selling wool in London, and had a wonderful grasp of all the details which go to make successful operations. Mr Goldsbrough was attracted to Australia by the stories of its great possibilities as a wool-producing country, and on his arrival in 1847 found Melbourne to be the most go-ahead of colonial centres. It is worthy of note in passing that in the year of his arrival the shipments of wool from Victoria only reached a total of 30,029 bales.

Very soon after his arrival he established himself as a stock and station agent, and also carried on a wool-scouring establishment. At this time one of the most progressive establishments in Melbourne was that of the Messrs. Bakewell, who did a big business as wool sorters. The idea was to put wool into proper shipping order, so that it would realize the best results at the London sales. An old authority describes the mode of operations of the firm as follows: 'The wool is assorted into two leading divisions of clothing and combing, and each of these descriptions is run out into five qualities, the fifth or lowest being the coarse Leicester breeds. Extra-fine lots are classed by themselves as super. Greasy or kempsy or other defective fleeces are also classed apart. The charge for sorting is ¼*d* per lb. The usual charge for hard washing is 1*d* per lb. on the weight returned, and for scouring 1*d* to 1½*d* per lb.'

Mr. Goldsbrough probably found wool-scouring a profitable occupation at this time, and his stock and station agency made great strides. In 1848 he conceived the idea of inaugurating a wool-selling business in Melbourne. Up to that time all Victorian wool had been shipped to London, and owners had to wait many weary months before learning how this wool had sold. As the smaller owners naturally found it inconvenient to wait, financial houses had been doing a very lucrative business in advancing on wool

and shipping it to London. A new era was opened up when Mr. Goldsbrough established local wool auctions and enabled owners to sell right out locally and receive a cash payment. The new industry went ahead by leaps and bounds, and the original premises soon became far too small. Mr. Goldsbrough's success was probably due to his unlimited energy and capacity for business, his grasp of details, and his progressive policy. He studied every detail of the business, and sought to perfect it at every point. He had the courage to try many innovations, and the ability to carry them through. His whole energies were concentrated on the one point of successfully establishing the selling industry, and his success was commensurate with his enterprise. Generous and openhearted, he took a sympathetic interest in every one in his employ, and in his day was one of the most popular men in progressive Melbourne.

In 1851 Mr Goldsbrough commenced his first bluestone warehouse off Market Street, Melbourne, but it was not completed until 1853 owing to the fact that the gold excitement led to an extraordinary exodus of all workmen to the auriferous fields. In 1853 Mr Goldsbrough joined Mr Edward Row and Mr George Kirk in the stock and station business. In 1854 he took Mr Hugh Parker into partnership with him, and that gentleman remained in the firm until his death in 1878. In 1873 Mr. J. S. Horsfall, who for many years previously had proved himself an almost indispensable adjunct to the business, became a partner, and on the 1st July, 1876, Messrs David and Arthur Parker, who had served in the business for a very long period, were admitted into partnership, making the firm then one of five members. The firm was consistently progressive, and by 1880 had put £150,000 into stone and mortar for the purpose of accommodating their business in wool and station produce. Year by year the firm found their accommodation inadequate, and extended it regardless of expense. Gradually the sales attracted large buyers of wool to the southern centre, and the operations increased each year until in 1880 the firm sold 63,076 bales out of a total of 78,512 bales sold, which at that time represented one-eighth of the wool produced in Australia.

Through Mr Goldsbrough's energies it was that Melbourne was established as one of the large wool marts of the world, ranking at that time next to London. Not only did Mr Goldsbrough seek to attract buyers from the Old Country, but he pioneered the trade with America. In 1877-8, 5277 bales were shipped from Melbourne to American ports, while in 1879-80 the trade was increased to 17,451 bales from Melbourne. During the latter period Sydney shipped 3000 bales to America. In 1881 the firm of R. Goldsbrough & Co. was amalgamated with the Australasian Agency & Banking Corporation (established in Melbourne in 1877), and was turned into a limited liability company. In 1881 R. Goldsbrough & Co. Ltd. opened up a branch in Sydney for the purpose of securing wool and shipping it to Melbourne for sale. In 1883 they started selling wool in Sydney, and in 1888 amalgamated with the Sydney pioneering firm of Mort & Co. Ltd., assuming the present title of Goldsbrough, Mort & Co. Ltd.

An early annual report of R. Goldsbrough & Co. shows how the founder of the business had set his heart on making Melbourne the wool depot of Australia. 'It is evident', says the report, 'that the sales in Melbourne have acquired a first-class position, and from their rapidly increasing popularity, both with sellers and buyers, we have good grounds for anticipating that they will annually assume greater importance. The grower can here realize the full value of his wool, and all further risk, so far as he is concerned, is avoided. His clip at once becomes the property of the manufacturers or merchant, and he can arrive at his exact returns without being dependent upon the fluctuations of the London market. The manufacturer, on the other hand, can, by buying here, gain a first selection of our clips, and by taking advantage of the lines of steamers now available via Suez, he can have the wool in his mills in seven weeks after he has purchased it here. Instead of waiting for the new clip to be offered at the February and March London sales, he can, by purchasing in Melbourne, place a good proportion of it in his factory by the end of December, thus gaining two clear months in the production of his new goods. The French, German, and American manufacturers and dealers have been quick to perceive the chances thus opened out, and they are present in this market each season in increasing numbers. The warehouses in Melbourne are probably unequalled in the world for storing and showing wool, and the natural advantages of its position as the seaport of the finest pastoral country in Australia have firmly established Melbourne as the chief wool mart of Australia. London has gradually monopolized the wool sales of Great Britain until it has become recognized as being almost the only mart for the trade, and in like manner Melbourne is, we believe, destined to become the great depot of Australia. The advantages of a recognized centre are obvious; the wool is concentrated in one place ready for the buyer, then undivided competition is thus secured, and their time is economized instead of being lost in attending local sales in each colony. The great superiority, quantity, and variety of the clips offered in Melbourne have combined to make it the leading wool depot of Australia, and a large quantity has been diverted here from the adjoining colonies for disposal. The rates of freight per steamers are in some instances almost nominal, consequently the extra cost of forwarding wool here is comparatively trifling.'

The history of the past twenty years has not fulfilled the prophecy of the Melbourne firm. Melbourne's pre-eminence as a wool-selling centre has been wrested by Sydney, but what has taken place in Australian markets is only a natural evolution. The wool grower has found it his most profitable policy to sell in the nearest centre, and with New South Wales producing the largest quantity of wool, the Sydney sales have won the premier position.

Histories of Selling Firms.- The largest wool-selling institution in Australasia to-day is Dalgety & Co. Ltd. This company was originated in 1843 by Mr. Frederick Gonnerman. Dalgety & Co in conjunction with Mr. Harry Gore established the firm of Dalgety, Gore & Co. The style of the firm was the same year changed to Dalgety, Cruickshank & Co., and on the death of Mr. Cruickshank in 1857, Mr Jas Blackwood came into the firm and the title was Dalgety, Blackwood & Co Combining the functions of a financial agency with those of an ordinary mercantile house, dealing in money as well as in merchandise, and extending its operations over a very wide area, the firm became one of the best known in Australasia It made advances upon stock and station property, and also upon wool and produce entrusted to it for sale in London In 1884 the firm was converted into a limited liability company with its present title. Very shortly after, the directors recognized the advantages of offering their clients the choice of either this or the London market, and a start was made at selling locally. In 1887 8 the company sold 16,337 bales in Melbourne, and in the same year they started selling in Sydney, turning over something like 18,000 bales

Elder, Smith & Co Ltd of Adelaide has a history dating back to 1840 In 1839 Mr A L Elder came out to Australia in a vessel of 89 tons, the 'Minerva', the property of his father, Mr George Elder, of Kirkcaldy, Scotland In 1840 he laid the foundation of the present business. The firm was conducted under the style of A L Elder & Co until 1853, when Mr. A. L Elder returned to England His brothers continued the business until Mr R Barr Smith joined them in 1854. Messrs. Edward Stirling and John Taylor were admitted in 1855, and the firm for some years was known as Elder, Stirling & Co. Mr Stirling retired in 1861 and Mr. Taylor in 1863, and Messrs Thomas Elder (afterwards Sir Thomas) and R Barr Smith became the sole partners, and the firm from that date was known as Elder, Smith & Co. Sir Thomas Elder was an energetic pioneer who did much to develop the resources of South Australia Mr R Barr Smith shared with him the control of the firm prior to 1888, when it was turned into a limited liability company, and he for some years after was managing director

The Australian Mortgage & Agency Co. Ltd, whose wool business was in 1904 acquired by the Australian Mortgage Land & Finance Co Ltd., was formed in 1880 In 1862 Mr. Hastings Cunningham, a well-known Victorian colonist and squatter, originated the firm of Cunningham & Macredie, under which style the business was carried on until 1868 Then Mr J K Smith took Mr. Macredie's place, the firm being known as Hastings, Cunningham & Co. In August, 1878, it was registered as a limited company, with a capital of £750,000 In 1880 it was merged into the Australasian Mortgage & Agency Co Ltd, of 100,000 shares at £10 each

The New Zealand Loan and Mercantile Agency Co Ltd. was incorporated on April 6, 1865 It was established for the purpose of stimulating the growth of wool through making advances to pastoral proprietors. They first started selling wool in Melbourne, and in the early eighties established a branch in Sydney to secure wool and ship it to Melbourne, but subsequently decided to hold auction sales in Sydney

Hill, Clark & Co. Ltd of Sydney dates back to the early days In the early 'sixties Durham & Irwin were selling wool On the death of Mr. Durham, Messrs Irwin & Turner carried on the business. The partnership was subsequently dissolved and Mr J A Turner continued the business Mr. Turner died in 1874, and the firm was merged into that of Marden, Hill & Co Mr. William Clark joined shortly after, and the firm was known as Marden, Hill & Clark. Subsequently the late Mr. George Marden withdrew and became Sydney manager of R Goldsbrough & Co Ltd, and the title of the firm was changed to Hill, Clark & Co It was turned into a limited company in 1909

Harrison, Jones & Devlin, Ltd., Sydney, is one of the old firms. In 1865 the late Mr L M. Harrison purchased the stock and station agency business of Mr Robert Forbes, and a few months later went into partnership with Mr. John R. Jones, the firm being known as Harrison & Jones. In 1866 Mr Richard Jones purchased his brother's interest, and the name of the firm was unchanged until 1870, when Mr James Devlin joined, and the title was changed to Harrison, Jones & Devlin Then turnover for 1871, the first year in which they sold wool, was 1502 bales

John Bridge & Co Ltd dates back to 1872, when Mr John Bridge started as a wool-selling broker Mr Bridge was a native of West Maitland, where he was born in 1831 He started life as a bank clerk, but came to Sydney in 1862, and got an insight into the wool-selling business while connected with Messrs. Irwin & Turner. In 1892 Mr. J F Hayes was admitted a partner. In 1896 the firm was turned into a limited company, all the shares being held by the family of Mr Bridge and Mr Hayes Mr Bridge died in 1897 in Scotland, where he was journeying for his health

Pitt, Son & Badgery, Ltd., springs from the stock and station agency established in the sixties by Mr G M Pitt. Mr Pitt was a Hawkesbury native, born in 1814. In the 'thirties he was one of the pastoral pioneers, holding Coorah Station, Gwydir He also held property at Moree and the Lower Macquarie Mr H S Badgery and Mr A Muggridge were admitted into partnership, and later on the firm was created a limited liability company The wool selling business was added to the stock-selling business about two decades ago

The Pastoral Finance Association, Ltd, was originally founded by Mr. J H. Geddes His father, Mr. John Geddes, was originally wool buyer for the oldtime firm of Prince, Ogg & Co In later years he was a speculating buyer and scourer. On his death his son, Mr J. H. Geddes, had the control of a large fellmongering business, and decided to start a wool-selling business He subsequently floated his business into a limited liability company, under the style of

J. H. Geddes & Co., the Pastoralists' Association, Ltd., based on co-operative principles. In 1891 this company was amalgamated with the Pastoral Finance Trust & Agency Co. of Australasia, Ltd., and the title was—J. H. Geddes & Co., the Pastoral Finance Association, Ltd. Mr. Geddes subsequently devoted himself to the frozen-meat industry. He died in London in 1909.

Schute, Bell & Co. Ltd., the youngest Sydney selling firm, was formed by Messrs A. Schute, F. D. Bell, W. Mylecharane, and E R. Moser, ex-employees of Goldsbrough, Mort & Co., during the present decade. It was converted into a limited liability company in 1909.

The firm of Winchcombe, Carson & Co. Ltd. was formed twenty-one years ago, the original partners being Messrs. F. E. Winchcombe, D Carson, C. L. Wallis, and E J. Turton. Mr. Winchcombe in 1868 was apprenticed to Mr. T. S. Mort to learn the wool-selling business He served his apprenticeship and afterwards rose to a high position with the firm, with which he remained up to the time of its amalgamation with R Goldsbrough & Co. Ltd of Melbourne. It was then that the firm of Winchcombe, Carson & Co. was established. Subsequently it was converted into a limited liability company, the original partners becoming permanent directors

Among oldtime wool-selling firms in Sydney were Messrs O B. Ebsworth, Richardson & Wrench, Irwin & Turner, J Devlin, junr., Brewster & Trebeck, Brunker & Wolfe, F L Barker, M'Burney, Wallis & Co, J C Young & Co., Wyly, Trenchard & Co., J H Geddes & Co.

Statistical Summary.—Unfortunately, records of the volume of wool sold in Sydney in the early days of the industry have not been preserved. The value of statistics was not generally recognized, and it was not until 1880 that an attempt was made to record the wool sales each year. Even then round figures were considered near enough, and not until a decade later were the actual figures kept on record. It is interesting to glance over the record since 1880 In that year the sales reached 50,000 bales, in 1885 they had reached 106,000, while in 1890 the total was up to 245,779. Five years later they had reached 415,538 bales, in 1900–1 they fell to 388,946 bales, in 1905 they rose to 630,728, while in 1909–10 they created the record of over 800,000 bales An increase in three decades from 50,000 to 800,000 bales is truly a record of marvellous progress

The following compilation shows the total sales of each year from 1880–1 to 1908–9:—

SYDNEY SALES

Season.	Bales Sold
1850	7,875
1880–1	50,000
1881–2	90,000
1882–3	73,000
1883–4	112,000
1884–5	112,900
1885–6	106,000
1886–7	120,000
1887–8	145,000
1888–9	200,000
1889–90	235,000
1890–1	245,779
1891–2	278,397
1892–3	362,365
1893–4	401,185
1894–5	425,135
1895–6	415 538
1896–7	401,048
1897–8	444,808
1898–9	446,845
1899–1900	396,839
1900–1	388,946
1901–2	522,003
1902–3	382,539
1903–4	375,322
1904–5	493,223
1905–6	630,728
1906–7	708,263
1907–8	599,003
1908–9	745,609

The following is a compilation of the total Victorian wool sales from 1875–6 to 1908–9, a period of thirty-four years It will be seen that, starting with 89,623 bales, steady progress was made, and up to 1891–2 the southern market was the most important in Australia Since that date, however, the supremacy has been with Sydney, but Melbourne firms have had their branches in Sydney and have kept their proportion of the trade. The record will be interesting—

VICTORIAN SALES

Season	Bales Sold.
1875–6	89,623
1876–7	108,827
1877–8	112,817
1878 9	104,236
1879–80	125,872
1880–1	122,272
1881–2	157,794
1882 3	155,850
1883–4	189,227
1884 5	180,045
1885–6	188,050
1886–7	214 876
1887–8	279,560
1888–9	217 508
1889–90	286,000
1890–1	250,000
1891–2	290,000
1892–3	311,000
1893–4	300,000
1894–5	328,142
1895–6	315,543
1896–7	310,385
1897–8	286,625
1898–9	280,397
1899 1900	312,465
1900–1	273,641
1901–2	321,483
1902–3	268,557
1903–4	249,338
1904–5	303,994
1905 6	367,179
1906–7	444,870
1907–8	392,622
1908–9	397,745

To illustrate the volume of business transacted in Geelong a record is given below of the sales in that centre from 1895–6.—

GEELONG SALES

Season.	Bales Sold.
1895–6	75,232
1896–7	79,093

Season	Bales Sold.
1897-8	70,702
1898-9	63,434
1899 1900	85,814
1900-1	78,851
1901-2	86,529
1902-3	84,721
1903 4	79,738
1904 5	93,888
1905 6	92,506
1906-7	102,321
1907-8	98,218
1908-9	101,772

The Brisbane wool market is comparatively young, but the development of late years has been remarkable When in the early 'nineties an attempt was made to inaugurate auction sales at Brisbane the results were far from satisfactory Buyers objected to journeying from Sydney, holding the belief that if they did not go up north the wool would come down to them The market was, however, established, and its progress is well exemplified in the following statistical summary of operations since 1898-9 —

Brisbane Wool Sales

Season	Bales Sold
1898-9	11,015
1899 1900	27 045
1900-1	13,453
1901 2	25,936
1902 3	14,754
1903 4	22,309
1904 5	38,660
1905 6	54,681
1906-7	79,727
1907 8	88,200
1908-9	148,616

The Adelaide wool sales have maintained a steady volume, and of late years have shown considerable expansion, viz —

Adelaide Sales

Season	Bales Sold
1895 6	80,234
1896 7	63,804
1897-8	51,287
1898-9	61,122
1899 1900	70,682
1900 1	42,637
1901 2	65,239
1902 3	61,215
1903-4	58,509
1904-5	71,018
1905-6	85,691
1906 7	105,925
1907 8	119,713
1908-9	134,701

The selling of wool in New Zealand has made material progress and shows signs of great vitality. The record for fourteen years is as follows —

New Zealand Sales

Season	Bales Sold
1895-6	82,965
1896-7	92,125
1897-8	101,501
1898-9	90,806
1899 1900	108,846
1900-1	90,235
1901-2	100,860
1902 3	121,836
1903-4	117,076
1904 5	165,711
1905-6	196,713
1906-7	180,734
1907-8	132,349
1908-9	207,989

The Tasmanian sales of wool are as yet in their infancy, but in less than a decade they have almost doubled, viz —

Tasmanian Sales

Season	Bales Sold
1902-3	12,293
1903-4	14,943
1904 5	20,045
1905-6	19,893
1906-7	18,279
1907-8	19,118
1908-9	21,852

Total Australasian Sales

Season	Total
1895-6	931,280
1896 7	867,362
1897-8	884,221
1898-9	890,185
1899-1900	915,877
1900-1	808,912
1901-2	1,035,520
1902 3	861,177
1903 4	837,497
1904 5	1,092,651
1905-6	1,354,866
1906-7	1,537,798
1907-8	1,351 123
1908 9	1,657,906

[Con]

Wool, Statistics of.—As the total number of sheep in the world is unknown, it follows that the total production of wool is still more uncertain Statistics of the world's flocks are, however, very largely available, and now comprise all but a few of the countries where sheep are kept From a recent return of foreign and colonial agriculture published by the Board of Agriculture and Fisheries (vol xlm, part iv), the following figures, representing the number of sheep in those countries where they are enumerated, are taken.—

British Empire (including U K.)	188,000 000
Europe (excluding U K)	125,000 000
Argentina	67,000 000
United States	55 000,000
Algeria, Mexico, and Uruguay	27,000,000

The figures for the British Empire and for Europe are fairly complete, but there are of course considerable gaps in the data relating to the rest of the world. Nevertheless, taking the figures as they stand, a total of 462,000,000 sheep is accounted for, representing an immense annual output of wool

So large a proportion of the wool crop of the world is sent to this country that the statistics of the trade in Great Britain may be said to represent the greater part of the dealings in that commodity The total imports of wool, including sheep's wool, lambs' wool, and alpaca, into Great Britain in 1908 and 1909 was as follows in quantity and value.—

	1908		1909	
	lb	£	lb	£
Sheep's or lambs' wool	719,041,881	27,997,328	803,432,566	31,886,369
Alpaca, vicuna, and llama	4,775,666	284,183	5,324,579	292,791
Total	723,820,547	28,281,511	808,757,145	32,179,160

The main sources of these imports are Australia, New Zealand, South Africa, India, and Argentina in the order named, Australia accounting for about 40 per cent and New Zealand for over 20 per cent of the total

A large proportion of the wool sent to this country, however, merely passes through on transit to other countries The re exports of colonial and foreign wool were as follows in the two years 1908 and 1909 -

	1908		1909	
	lb	£	lb	£
Sheep's or lambs' wool	325,450,840	12,840,735	390,106,753	15,916,535
Alpaca, vicuna, and llama	861,549	52,106	588,429	33,334
Total	326,312,389	12,892,841	390,695,182	15,949,869

It will be seen therefore that not more than from 52 to 55 per cent of the total imports of wool are manufactured here, the principal countries to which they are transhipped being the United States, Germany, France, and Belgium

There is, however, an addition to be made for the wool grown in this country, the quantity of which varies according to the number of sheep; but in recent years it has been estimated at from 130 to 140 million lb. From this, again, there is a large deduction to be made for export In the last three years, the exportation of sheep's and lambs' wool grown in the United Kingdom has been as follows.–

1907		1908		1909	
lb	£	lb	£	lb	£
30,955,300	1,790,386	37,837,300	1,476,972	62,268,000	2,750,015

The quantity of home-grown wool exported has increased in recent years very considerably, and the quantity sent abroad in 1909 greatly exceeded previous records

It appears from these figures that the total quantity of wool used in this country for manufactures is somewhere about 500,000,000 lb

As has already been said, the quantity of wool produced in the United Kingdom is a matter of estimate. Attempts have been made at various times to make a reliable calculation, and year by year commercial estimates are published which no doubt approximate roughly to the facts The most recent, as well as the most exhaustive, enquiry into the subject was that made by the Board of Agriculture and Fisheries, the results of which are published by the Board in a Report on the Production of Wool in Great Britain in 1905 and 1906 Enquiries were made in every county and for all the principal breeds of sheep, and on the basis of replies from a large number of flockmasters as well as wool buyers, estimates of the average weight of fleece in each county and for each breed were made The general average weight of fleece for breeding ewes was 5⅜ lb, and for other sheep of one year and above, 6¼ lb From a number of returns from wool buyers representing the actual weight of fleeces passing through their hands, the average washed and unwashed fleece of some of the chief breeds was calculated as follows —

	Washed	Unwashed
	lb.	lb
Blackfaced	3⅜	4⅝
Cheviot	4	4⅛
Cotswold	8	–
Hampshire	4⅞	6⅞
Leicester and Lincoln	10¼	14½
Oxford Down	6¼	8½
Shropshire	5⅝	8¼
Southdown	4½	6⅝
Suffolk	4¼	6⅜

The following was given as an approximate estimate of the total annual production of wool in the United Kingdom in 1905–6.—

	lb
Sheep shorn	87,838,000
,, slaughtered	30,250,000
Lambs shorn	2,000,000
,, slaughtered	1,000,000
Total for Great Britain	121,088,000
,, Ireland	12,000,000
Total for United Kingdom	133,088,000

As the number of sheep in the country has increased by over two millions since this estimate was made, the output of home-grown wool probably now exceeds 140,000,000 lb. per annum.

[R. H. R.]

Wool Balls, a frequent cause of mortality among lambs. See art. Balls, Hair Balls, and Concretions.

Woolless Sheep. Wild sheep in a natural state have a coat of two kinds, the ordinary covering of coarse close stiff hair which appears on the surface, and an underclothing of wool beneath it. In nearly all varieties of domestic sheep the underwool has been developed to an extraordinary extent by generations of selective breeding, until in the majority of cases the normal hairy coat has been to all intents and purposes lost. It is this growth of the underwool, constituting the so-called 'fleece', that gives to domestic sheep their great economical value as wool producers. In some tropical breeds of sheep less specialized than European breeds there is a considerable percentage of long hair interspersed in the wool. These types are in a sense intermediate between the ordinary sheep with woolly fleece and the so-called woolless sheep which resemble wild species in having a hairy coat with a relatively small amount of underwool. The best-known examples of hairy or woolless sheep are the so-called Maned sheep of North Africa, of which at least three well-marked varieties are known, one being a short-tailed variety from Abyssinia, a second the long-tailed so-called Hausa or Nigerian sheep, sometimes called the long-legged sheep, and the third the long-tailed Dwarfed sheep of the Cameroons. In the Hausa and Nigerian sheep the females are horn less, but the rams bear horns of varying slope and length, sometimes extending laterally with a spiral twist, sometimes curling and quite short. Another variety is met with in some of the West Indian islands in which horns are absent in both sexes. The rams of this breed have probably lost their horns since being exported from West Africa years ago at a time when there was extensive traffic between the two countries. See Argali, Mouflon, Maned Sheep. [R. I. P.]

Woolly Blight, also called the 'American Blight', is caused by a scale insect, *Schizoneura lanigera* (see this article).

Woolly Soft Grass, a name commonly applied to Creeping Soft Grass. See art. Holcus.

Wool Refuse is sometimes used for manurial purposes. See Nitrogenous Organic Manures.

Workmen's Compensation Act, 1906. This Act, passed on 21st December, 1906, supersedes and consolidates the original Act of 1897 and the amending Act of 1900, although these Acts still apply as regards accidents which happened prior to 1st July, 1907, when the Act of 1906 came into force.

The chief object of the Act is to make the employer of labour liable to pay compensation to his employees who, through accident arising out of and in the course of employment, are disabled from earning ordinary wages, or to any persons who are dependent on employees who sustain fatal injuries in connection with their employment.

The Act gives compensation for accidents resulting in disablement for more than a week, and does away with the restrictions which limited compensation to accidents happening in, on, or about the premises of the employer.

Compensation can only be claimed where the accident is directly due to the injured person's employment and has happened in the course of the employment. Further, the injury must cause total disablement for a period of at least one week, *i.e.* the injured person must be incapacitated from earning for one week following the accident full wages at the work at which he was employed. No claim to compensation can be made where the injury is due to serious and wilful misconduct, unless the injury results in death or serious and permanent disablement.

The Act applies to practically all farm, estate, and domestic servants, but there is an exception in the case of any person whose employment is of a casual nature, and who is employed otherwise than for the purposes of the employer's trade or business. Extra hands whom a farmer engages for haymaking or harvesting, though employed casually, are entitled to compensation because they are employed for the purposes of the employer's business. It may be a question whether a boy employed casually as a beater by a game tenant would be entitled to compensation, because it could scarcely be said in such a case that the boy was employed in connection with the business of the employer. So it has been said that a boy who is engaged by a traveller to carry his bag or other personal luggage to or from the station, or a tramp engaged out of charity to clear away snow from the doorsteps of a dwelling house, could not be said to be employed for the purposes of the employer's trade or business. A member of the employer's family dwelling in the employer's house is not entitled to compensation.

An employer does not escape liability for injury to his employee whose services have been lent or let on hire to another person.

Certain contracts for agricultural work are dealt with exceptionally by the Statute. Where a person contracts with a farmer to do threshing, ploughing, or other agricultural work, and in order to execute the contract provides and uses machinery driven by mechanical power, he alone will be liable to compensate the workmen whom he employs. No claim can be made against the farmer by the contractor's workmen.

Where the injuries result in death the compensation is as follows —

1 If the workman leaves any person wholly dependent upon his earnings, £150 or three years' earnings, whichever is the larger—maximum £300. Three years' earnings are interpreted to mean, the amount earned by the workman in the employment of the same employer during the three years immediately preceding the injury, or, if the workman has been employed less than three years, a sum equal to 156 times his average weekly earnings in that employment.

2 If the workman leaves persons partially dependent, the compensation is such sum not exceeding the amounts specified in (1) above, and will be reasonable and proportionate to the loss sustained by such dependants.

3. If no dependants are left, the employer is only liable for the reasonable expenses of medical advice and burial up to a maximum of £10.

Where the injuries do not result in death, but in disablement, the compensation is as follows:—

1 Total disablement—a weekly payment while the disablement lasts, to the extent of not more than half the average weekly earnings, not exceeding £1 No compensation is payable for the first week if the disablement lasts less than two weeks.

No compensation is payable at all for injuries which last only a week or less.

2. If the workman be only partially disabled, the compensation must not exceed the difference between what he was earning before the accident and the amount he is earning (or is able to earn in some suitable employment or business) after the accident, but has to bear such relation to the amount of that difference as under the circumstances of the case may appear proper

There is a special scale in the case of a workman who is under twenty-one years of age at the time of the injury. If his average weekly earnings were less than £1, the weekly payment may be any sum up to 10s If the disablement lasts more than twelve months, the weekly payment may be increased on the application of the workman to half the weekly sum which he would probably have been earning at the time of the application if he had remained unmjured, subject to a maximum of £1. [I. C]

Worms, a general name for a heterogeneous series of classes, such as Flukes, Tapeworms, Roundworms, Earthworms, which have not very much in common Altogether there are about a dozen of these classes, and their relationships to one another are imperfectly known It was with 'worms' that bilateral symmetry began, *i.e.* the possession of head and tail, right side and left side; and it is among the simplest 'worms' that we find the first indication of head-brains or cerebral ganglia. They are indeed of great evolutionary interest because they show the beginnings of many structures which become of great importance in higher animals The practically important 'worms' may be classified in the following scheme:—

A Unsegmented flatworms, either internal or external parasites, with attaching suckers, with a blind food-canal, hermaphrodite, in many cases requiring two hosts for the completion of their life-history· TREMATODES or FLUKES, *e g.* Liver Fluke (*Distomum hepaticum*).

B Flatworms almost always forming a chain of joints, internal parasites, occurring (with one exception) in two hosts—the young bladderworm stage in one, the adult tapeworm stage in the other, with attaching suckers in the adult, with no food-canal, hermaphrodite. CESTODES or TAPEWORMS, e g. *Tænia cœnurus*, sturdie-worm in sheep, *Tænia solium*, 'measles' in pig

C Cylindrical unsegmented worms with a firm glistening cuticle, some parasitic, some free-living, with an open food-canal, usually with separate sexes· NEMATODES or THREADWORMS, e.g. *Ascaris megalocephala* of the horse, *Tylenchus tritici* in wheat ears.

D. Horse-hair worms, threadlike, superficially like Nematodes, the young occur in aquatic insects and emerge to become adult in the pools: e.g. *Gordius aquaticus*, the common horse-hair worm.

E. Unsegmented cylindrical forms, superficially like Nematodes, without any food-canal, with a protrusible hooked proboscis at the anterior end, the young stages live in insects and crustaceans, the adults in backboned animals. ACANTHOCEPHALA, e g *Echinorhynchus gigas*, which passes from larval beetles (Blaps) to the rat

F. Segmented cylindrical forms, with bristles on the segments, with a well-developed food-canal, hermaphrodite, without larval stages, living in fresh water and in the soil OLIGOCHÆTA, a subdivision of Chætopods, within the large series of Annelids or segmented worms; *e g* the common earthworms (Lumbricus, &c.) and freshwater worms (Tubifex, Nais, &c)

G Segmented more or less flat forms, with superficial rings much more numerous than the genuine segments of the body, usually with two suckers, very rarely with bristles, almost all hermaphrodite, without larval stages· HIRUDINEA or DISCOPHORA, Leeches, e g. *Hirudo medicinalis*, the medicinal leech

Besides these there are other sets of 'worms', and the term is so vague that it should always be qualified by some prefix. This is the more necessary since the same word is used in reference to some larval stages of insects, *e g* the 'blood-worm' (Chironomus), the young of the harlequin fly, and 'silkworms', the caterpillars of the silk-moth

See numerous special articles, *e g* BLADDER-WORMS, CESTODES, EARTHWORM, FLUKES, NEMATODES, PARASITES, TAPEWORMS [J. A T]

Worms in Horses and Cattle.– In the present article we desire to call attention to the ill effects of the common worms with which agriculturists are more or less familiar, and point to some of the means of prevention, and of expulsion from the body when known to be present.

The agriculturist cannot afford to maintain worms, and should not be misled by the half-truth frequently stated, that a few are of no great consequence It should be remembered that their power of reproduction is so great that, given a favourable season, a dozen or two can breed millions Cobbold estimated each segment of a tapeworm to be capable of producing 30,000 eggs We know that the roundworms and the flukes are also very prolific.

When animals do not prosper on a fair ration, worms should be suspected, and evidence sought in the evacuations. A large proportion of the internal parasites of horses and cattle have an intermediate life in other creatures, or in moist earth, or ditches, drains, and undisturbed floors of buildings. It is important, then, that we should destroy their intermediate bearers, and break up their homes. The molluscs which act as nurses to many varieties cannot endure salt, and a 1-per-cent solution has been found sufficient to kill the fluke. We can spread it with soot and lime upon the land. Ditches can be thrown and exposed to the heat of the sun in suitable seasons. Floors and drains can be cleansed, and worms destroyed by flushing the latter with approved disinfectants

The infested animal is treated by giving vermifuges, and any tonics which enable him to overcome the ravages of parasites. All the roundworms are susceptible to turpentine, if it can be brought into contact with them. (See MEDICINES, DOSES OF.) Santonine and carbolic acid, iron, salt, bitter barks and roots, either kill or hinder propagation. Areca, kamala, oil of male fern, jalap, calomel, aloes, and other anthelmintics are used, but uncertainty marks the use

of all worm medicines. See Ascaris, Hoose, Gid, &c. [H. L.]

Wormwood. See art Artemisia.

Wound Rot in trees is mostly occasioned by fungi belonging to the Hymenomycetes order, of which the chief genera are Trametes, Fomes, and Polyporus. Most of these fungi commence their attacks by being saprophytic on any parts of the tree killed by accident or injury, and then subsequently invade the living tissues parasitically. The danger of wound rot is always greatest when the surface is rough and apt to remain wet after rainfall, thus tending to afford a good germinating bed for fungus spores. From the nature of their tissue, softwoods and conifers are most liable to be attacked by wound fungi, but hardwoods also suffer in the same way. The danger of wound rot is of course greatest when the wound surface is large, and the only means of preventing it is to prune in such a manner as to provide a clean smooth sloping surface from which rainwater can easily drain off, and then give it a good coating of tar. The best time for thus pruning and treating antiseptically is just before the fall of the leaf in autumn. [J. N.]

Wounds.—Simple incised, contused, lacerated, and punctured wounds are those with which the stock-keeper will have to deal. Antiseptic dressings are desirable in all cases, and should be applied at the earliest possible moment (See Antiseptics.) Wounds heal chiefly by two processes—adhesive inflammation, and suppuration and granulation. In the case of a simple severance of tissue, as when a knife is the cause, and when no foreign matter or organisms have had access, the former kind of union may be expected. When the tissues have been torn, as for instance in a broken knee, such union cannot be expected. Incised wounds, not suspected of containing any foreign substance, should be quickly bound up, not bathed and deprived of the blood clot which would otherwise assist the edges to come together. The situation and extent of the wound will determine the need of bandages, stitches, or other means of bringing the lips into apposition, unless approximated, union by adhesion cannot take place. Protection from external influences is all that is necessary in this form of healing. Contused and lacerated wounds may benefit by warm fomentation and poultices, which facilitate circulation and the passing out of grit and deleterious substances in the discharges. The appearance of yellow thick pus is a healthy sign of granulation beneath. A brick-red, thin, and variable discharge is a bad omen and suggestive of dead tissue within and the possible formation of fistula. (See Fistulous Withers, Broken Knees, and Quittor.) The good surgeon conserves all skin, consenting with reluctance to trim away the most ragged portions, as these will often come together in the end. This applies specially to torn eyelids (see Eye, Diseases of). Granulations may be profuse and need repression, and for this purpose caustics, as copper sulphate and nitrate of silver, are employed. Proud flesh is the name given to excessive growth of granular tissue. Checking it leads to the desired object of leaving the minimum of blemish when cicatrization or the formation of a scar finally closes the breach.

Punctured wounds, such as are caused by hay forks, may generally be enlarged with advantage, as the chief risk is in pocketing of matter and want of drainage resulting from swelling. The insertion of a plug or tent of tow dipped in black oils or similar caustic substances will often prevent the wound from too early closure. [H. L.]

Wren (*Troglodytes parvulus*) – This small brown bird, the type of a special family of perchers, and distinguished by a white line over the eye and a square-ended upturned tail, is widely distributed through Britain, and resident throughout the year. It is usually seen in hedges or undergrowth, and builds its large domed nest in the ivy of a tree or wall, moss and leaves lined with feathers forming the materials. The five to nine eggs are shining white, with red spots at the broad end. The Wren feeds on insects and the like, supplemented by wild fruits and berries in the winter. It is entirely beneficial to agriculture, and there is no excuse for its persecution. [T. R. A. D.]

Wurzel Fly. See Pegomyia beta.

Wyandotte Fowl.—The Wyandotte (an American breed) is a medium-sized, active, compact bird, cobby in build, with a neat rose comb,

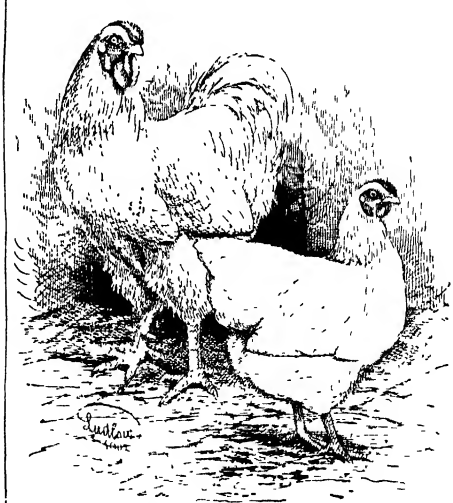


Fig 1.—White Wyandottes

not standing upright like that of the Hamburgh, but curved over the skull; legs of medium length, which, together with the flesh and skin, are yellow in colour. In shape the hens are well balanced before and behind, but the tail is not carried high. These birds are full in feather, giving them a somewhat heavier appearance than is justified by the weights, which range from 5½ to 8 lb. in accordance with the sex. No breed has had a similar number of varieties created in the same time as the Wyandotte. Of

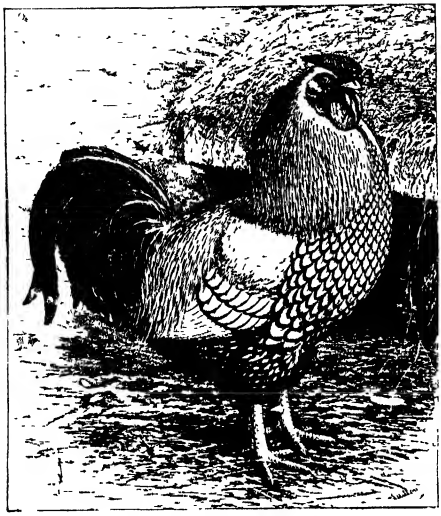


Fig 2 —Silver Wyandotte Cock

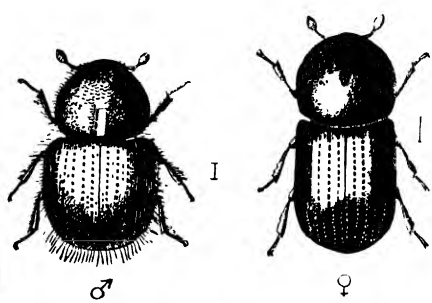
these there are now nine. First, after the original Silvers came the Golds, formed by crossing the former with the Rhode Island Red, thus producing the rich golden bay ground colour in place of the silvery white, with lacings, as they are called, that is, a narrow edge of black to the body feathers of the hen and those on the breast and under parts of the cock. Since then, White, Black, Buff, Partridge, Silver Pencilled, Buff Laced, and Columbian have been introduced, the four last named mainly for exhibition purposes. Whites and Blacks are sports from the Silvers, and Buffs were obtained by crossing the Buff Cochin on White and Gold Wyandottes. The quality which first gave this breed its popularity was the fact that they proved to be excellent winter layers. The eggs are tinted in shell and very round, at first they were somewhat small in size, doubtless owing to the Hamburgh influence, but selection in breeding has effected considerable improvement in that direction. In respect to the different varieties, the best known for practical purposes are Whites, Golds, Silvers, and Buffs, and their degrees of popularity are represented by the order in which these are placed. Of the four named, the Buffs give the largest eggs, with Whites and Golds following. In spite of the flesh and skin colour, which is creamy rather than deep yellow, White Wyandottes are good in meat qualities and fatten well, making plump, meaty birds. All are hardy, good growers, excellent foragers, and thrive equally well whether on farms or in confinement. [E. B.]

Wych Elm. See Elm

X

Xestobium, a genus of wood-boring beetles of which the Death Watch (*X. tessellatum*) is the best known. It is a stout reddish-brown beetle with small patches of pale hairs, and is about ¼ in. long. It is very destructive to the timber in houses, churches, barns, &c., and like most wood feeders it is long-lived in the maggot stage, frequently taking two or three years to mature. The curious ticking noise they produce must be familiar to the reader. They also occur in old Oak and Willow trees. The only way to cope with these pests where they attack the wood work of rooms is frequent fumigation with either sulphur or hydrocyanic acid gas in July, and then washing down with strong carbolic. Where parts that can be easily reached are attacked, then washing with a 2-per-cent solution of corrosive sublimate is all that is necessary, the beetles are poisoned as they escape if this is allowed to dry on the woodwork. Furniture may be painted with the corrosive sublimate now and again, or with ordinary benzine; if the latter is used a good quantity is required, so that it soaks into the holes in the wood. [F. V. T.]

Xyleborus dispar is a small boring beetle, exceedingly destructive to the wood of various deciduous trees, and particularly to fruit trees and oak saplings. It is a local insect, and its severest attacks have generally occurred on the Continent, but it has also done considerable harm in Gloucestershire orchards. The beetle, which does not exceed ⅛ in. in length, appears in May, and burrows deeply into the wood, generally near the origin of a branch. The grubs which hatch out from its eggs strike off at right angles from the entrance gallery and follow the annual rings, and from these



Xyleborus dispar, male and female. (From Schlich.)

transverse secondary tunnels, tertiary vertical tunnels are bored.

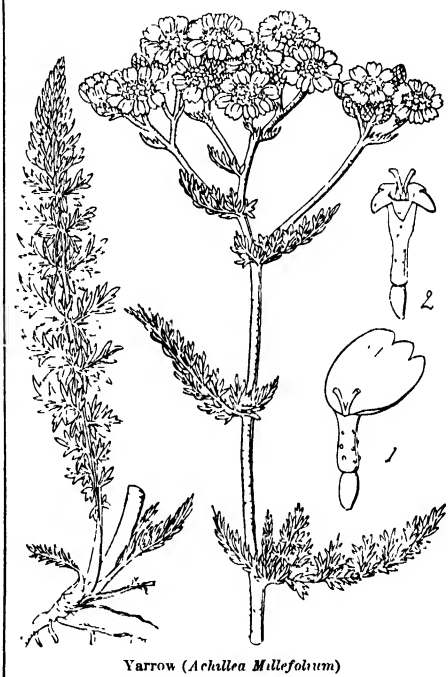
Badly attacked trees should be removed and burnt. The use of unbarked orchard props should be carefully avoided, for these harbour the beetle and are a source of danger to the growing trees. [C. W.]

Y

Yak (*Bos* or *Poephagus grunniens*), a species of the ox tribe which occurs both in a wild and domesticated state, ranging at high altitudes on the plateau of Tibet and spreading into the Kansu province of China. In certain cranial characters the Yak is intermediate between the true Oxen, typified by the European races of *Bos taurus*, and the Bisons (*Bos americanus* and *B. bonasus*). (See Bison.) It possesses well-marked external characteristics, however, which serve to distinguish it at once from both these groups. In the first place the top of the muzzle, instead of being naked almost as far back as the posterior corner of the nostril, is covered with short hair as far forwards as the anterior corner. In the second place there is a mat of long hair extending from the chest, across the shoulder, along each side of the lower half of the body and across the thigh, while the lower half of the tail is similarly covered with long hair. This peculiar development of hair, not found in any other species of cattle, probably serves the purpose of a protective pad against the cold of the snow upon which the animal habitually lies. The back is literally straight, the quarters but little sloped, the withers high and arched, the head carried low, and the legs short with broad hoofs. The horns are cylindrical and smooth, and rise from the sides of the head with at first an outward and upward curvature, followed by a forward and inward curvature, the tips being directed inwards, upwards, and in some cases slightly backwards. The hair is short over the neck and the upper parts of the body; and the colour of the wild animal is nearly black with some white round the muzzle. The height of a wild bull varies between 5½ ft. and 6 ft., and the animal weighs about 1200 lb. Cows are considerably smaller and have smaller horns. The voice, as the specific name indicates, is a snorting grunt, like that of the Zebu, and quite different from the lowing call of the other domesticated cattle of India, the Gayal or Mithan (*Bos frontalis*), and of European breeds. On the high plateau of Tibet Yaks range in the summer up to elevations of 20,000 ft., and live almost exclusively upon coarse mountain grass. Domesticated forms which are reared at lower levels deteriorate in size and not infrequently lose their horns, giving rise to a polled variety. Their colours also become varied, white or black-and-white individuals being commonly seen. The tufted tails of white specimens are used as *chowris* or fly-flicks in India. The period of gestation is said to be ten lunar months, the young being born in the autumn. Tamed Yaks are kept by native Tibetans and by tribes of the upper Himalayas for their milk and flesh, and are also employed for carrying merchandise. [R. I. P.]

Yarrow, or **Milfoil** (*Achillea Millefolium*), is an underground creeping perennial regarded now as a plant to be sown, now as a weed to be destroyed. It is a Composite with watery juice, finely divided, fernlike leaves, and tough woody stems 1 to 2 ft. high, branching out towards the apex so as to bear the numerous small white or pink flower-heads. Underground runs an extensive horizontal branched stem (creeping rootstock), which propagates the plant and confers upon it the character of a perennial.

Yarrow grows freely on sandy calcareous soils of the poorest and driest type. Accordingly, it is very suitable for covering rabbit warrens, and for this purpose it should be sown at the rate of 5 lb. per acre. Besides, sheep readily eat the leaves, and for early feed on poor pastures ½ lb. of Yarrow may be included in the



Yarrow (*Achillea Millefolium*)

1, Ray floret. 2, Disk floret

mixtures sown. But farm animals refuse the woody stems, therefore for hay production this plant is quite useless. On the whole, then, Yarrow should not be sown, except for permanent pasturage on poor, dry, sandy soils. Wherever it is apt to spread extensively and to oust plants of a more productive kind, Yarrow is rightly looked upon as a weed.

When good meadows and pastures are overrun with Yarrow, improvement may be effected by applying manures favourable to grass but inimical to Yarrow, such as farmyard dung, nitrate of soda, or sulphate of ammonia. [A. N. M'A.]

Yaur, or **Yarr,** a provincialism for the weed commonly called Spurrey. See Spergula.

Photo Irwin

YAK

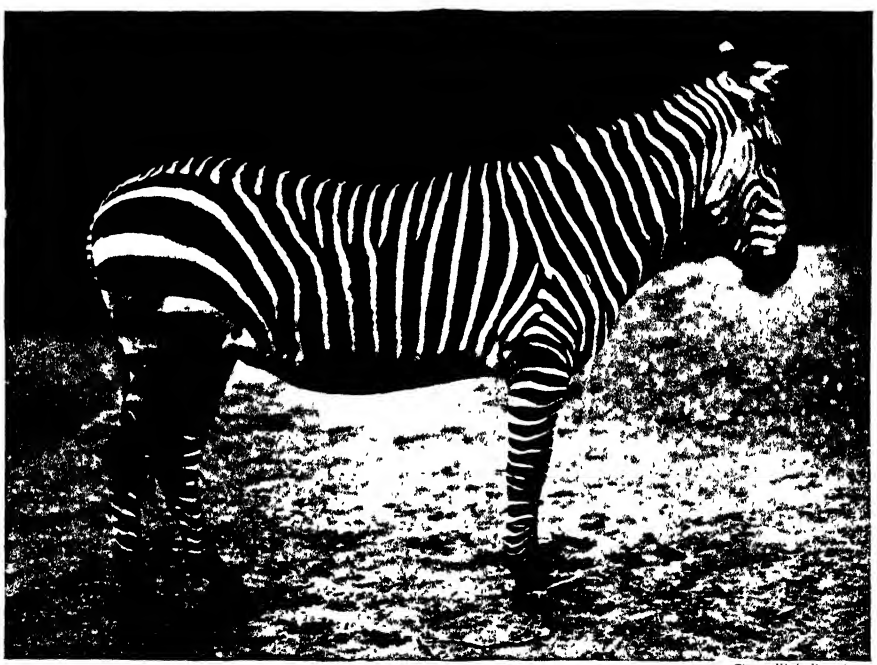


Photo W. S. Berridge

MOUNTAIN ZEBRA

Yeast, or **Barm** (Saccharomyces and Torula), is the name applied to plants cultivated in vats containing malt extracts for beer production, and grape or fruit juice for wine production. Whereas ordinary plants are cultivated in soil for crop, yeasts are grown in a liquid medium—the *plasma*, not for crop, but for the plasma itself. The crop is the valuable product in the one case, the plasma in the other. When yeast is growing in a sugary medium it sets agoing in the liquid certain processes to which the collective name *fermentation* is applied. Sugar disappears and alcohol takes its place: this is the result of alcoholic fermentation. At the same time carbonic acid gas is produced in abundance which saturates and supersaturates the liquid, bubbling out from the foaming surface – this means 'gassy' fermentation. In addition to alcohol and carbonic acid, glycerine and succinic acid appear, also subtle substances which communicate their own characteristic flavour and aroma. If this flavour happens to be pleasing, the yeast which produces it is taken into cultivation, *e.g.* Beer Yeast (*Saccharomyces cerevisiæ*); if bitter and unpleasant, this yeast is considered a pest, like the weeds of agriculture, *e.g.* Bitter Yeast (*Torula amara*). These wild yeasts not only plague the beer and wine vats, but also infest dairy produce, milk, butter, and cheese, acting hand in hand with their accomplices the *microbes* or *bacteria*. Thus we see that bitterness and 'gassiness' in dairy produce may at times be accounted for by the presence of weed yeasts. We see also that certain yeasts which produce exquisite flavour and aroma might with profit be used in connection with the dairying industry. Already we know the Caucasian beverage *Kefir*, produced by inoculating milk with the yeast called *Torula kefir* and certain bacteria, the Tartarian beverage *Koumis*, produced by adding Beer Yeast and sugar to milk; and the Armenian Curd *Mazun*, dependent upon the presence of a yeast—*Saccharomyces Pastorianus*. In order to understand how the changes above referred to come about, we will consider yeast briefly under the following heads: (1) the food supply, (2) the power supply, (3) the mode of multiplication, (4) the mode of spread, and (5) the distinctive features.

1. Pasteur spent much time and labour in finding the actual sources of the food supply. He wanted to make up a liquid in which the yeast could grow and multiply. He found that he obtained a fertile plasma by making a solution of cane sugar in distilled water and adding thereto a simple compound of nitrogen (*e.g.* tartrate of ammonia), with a little ash from the end of his cigar. Although no albumin is provided, the yeasts, though constantly increasing in number, are always full of albumin, and fat is also present. We thus behold yeast as a creature having no need for extraneous albumin and fat supplies, and also as a workshop in which these stuffs are being manufactured. Such work must be accompanied by a profound change in the surrounding medium, and many hangers-on, such as bacteria, will be attracted to the manufactured foodstuffs. Yeast never attacks living matter, but always fixes on dead organic substance as a source of food, using the sugar contained therein, and not troubling itself about the manufacture of albumin if it gets this latter ready-made.

2. Pasteur also directed his especial attention to the source of the energy required for the various manufacturing and vital processes carried on by the yeast plant. Light has here nothing to do with power supply, for in darkness full activity is displayed. Oxygen, however, disappears from the surrounding medium and carbonic acid gas is produced. In a word, yeast respires to get energy just like other living beings. As a consequence it produces many and varied waste substances, which are excreted from the yeast into the surrounding plasma. Thus again we see that any liquid in which yeast is living must undergo a profound change. When we consider further that this organism can make use not only of the free oxygen dissolved in the plasma but also of combined oxygen in sugar, its powers as an agent of change force themselves still more strongly upon us.

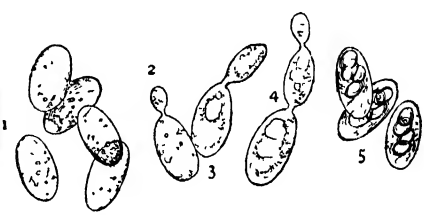


Fig. 1, Cells of common Beer Yeast (*Saccharomyces cerevisiæ*). Figs. 2, 3, 4, Successive stages of "budding" process of multiplication. Fig. 5, Cells containing endospores. (All enlarged about 750 diameters.)

3. The process of multiplication is easily observed and understood. Once the plant has reached its full size (about $\frac{1}{3000}$ in.), the contents (protoplasm) begin to press strongly upon the surrounding wall of the cell. At some weaker spot a bulge is produced (fig. 2), and this bulging portion (the *sprout*) begins to drink, to feed, to breathe, and to grow on its own account, although still connected with the parent. Now one yeast plant has become two (fig. 3). This simple sprouting process repeated again and again in a short time suffices to transform a few yeast plants introduced on the point of a needle into myriads. A clear plasma so inoculated soon becomes turbid all through, and this turbidity is due solely to the multiplication of the yeast plant. Beer Yeast multiplies most rapidly at a temperature of 70° F. When multiplication is rapid the sprouts remain attached to one another, forming chains of four to six plants (fig. 4); but when slow, the sprouts become detached as they are formed, and the plants are now isolated (fig. 1).

4. The wide spread of yeast in air, in water, in soil, and in all sorts of dead organic matter is easily accounted for. The plants are minute ($\frac{1}{3000}$ in. diameter), very light, and can be dried without losing their vitality. In this state the wind can carry yeast as an impalpable dust, and deposit it anywhere and everywhere.

5. Yeast among bacteria is like the great Gulliver among the pygmies—it is about ten times as broad as the bacteria, and thus distinction is easy. It is oval or round, very like a red blood corpuscle in shape and in size, but easily identified by its 'sprouts' (fig. 2) It is not easy to determine without special experiments whether a yeast before us is to be called Saccharomyces or Torula. If, however, the behaviour of the plant growing under conditions of hardship is observed, the Saccharomyces is known by the formation of internal spores (usually four in number, fig.), and the Torula by the absence of spores under similar conditions

[A. N. M'A.]

Yellow Clover. See CLOVERS

Yellow Marigold, Corn Marigold, or **Yellow Ox-eye** (*Chrysanthemum segetum*) is a well-known annual weed-plant of the nat. ord. Compositæ, with watery juice, bluish wax-coated leaves, and large handsome golden-yellow flower-heads borne by stems that rise 1 ft. or more above the ground. It often grows abundantly on non-calcareous sandy soils, injuring both corn and turnip crops. The flowering period extends from June to September. Each plant can produce over one thousand 'seeds' (cypselas), so light, so flat, and so expanded at the sides that the wind readily catches them up and scatters them to a distance. Thus a luxuriant growth of Marigolds on neglected ground may infect a whole neighbourhood. This pest of sandy soils always starts from seed, never in any other way, so that if no seeds are in the land to begin with, and if none get in from extraneous sources, the Marigolds cannot by any possibility spring up. But any number of effective seeds may well be in the land although for years no Marigold has appeared upon it. The fact is that this seed, like the seeds of the Mustard weeds and others, can lie dormant in the soil, and by and by, when brought to the surface, reproduce its kind. To reduce the seeds in the land the only effective plan is to bring as many as possible to the surface, so that they may be induced to germinate and produce their seedlings. Ordinary tillage will destroy the weed at this weak stage of growth. When the land is unusually foul it may be advisable to take two cleaning crops in succession.

To prevent renewed contamination of the land with Marigold seed, certain precautions should be taken.

1. Prevent seeding of any plants that come up, by hand-pulling, and burn the weeds.

2. Burn chaff, &c., containing these seeds.

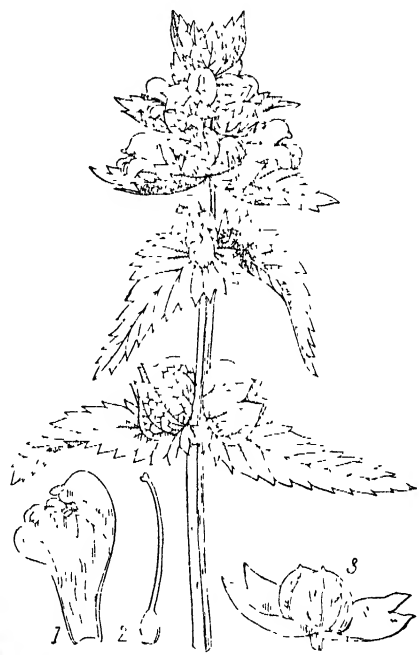
3. Sow seed free from this impurity—particularly corn, clover, and grass.

4. See that centres of infection in the neighbourhood are prevented from seeding.

Advantage may also be taken of the circumstance that Corn Marigold does not thrive on land well dressed with lime. [A. N. M'A.]

Yellow Milk.—Several bacteria cause yellowness in milk, more especially if the milk has been kept standing for a time. The best-known species is *Bact. synxanthum*, a rodlike organism which gives rise to a bright-yellow colour; the casein of the milk passes into solution, and the milk becomes alkaline. The yellow colour is not produced in acid milk. [R. H. L.]

Yellow Rattle (*Rhinanthus crista galli*) is a yellow-flowered annual belonging to the Foxglove order Scrophulariaceæ. This weed has two specially bad points. In the first place it is a partial parasite which preys upon the roots of grasses, interfering with the growth and nutritive value of plants within its reach. Secondly, the seeds are poisonous from the presence of an active glucoside called *Rhinanthine*, hence hay containing ripe Yellow Rattle should never be fed to stock. In poor damp or wet meadows and pastures, the Yellow Rattle occurs frequently; sometimes it is found on chalk downs, and occasionally in the grain crop on arable land. Any contaminated grain or flour is unfit for use. Grazing animals rarely touch the weed, and so it is allowed to seed freely.



Yellow Rattle (*Rhinanthus crista galli*)

1, Corolla opened out. 2, Pistil. 3, Fruit.

The plant is easily recognized. From the taproot there rises a rigid quadrangular stem 6 to 18 in. high, bearing pairs of narrow lanceolate leaves with serrate margins. From May to July the flowers are produced in the axils of the upper leaves. The two-lipped yellow corolla with its upper lip flattened laterally is very characteristic. When the corolla falls away, the bladdery calyx (also flat), ¼ to ½ in. in diameter, is the conspicuous part. In its interior is the capsule fruit containing several flat seeds. When ripe, this capsule opens by two valves, and the wind readily scatters the seeds, which

have a wing all round the margin to facilitate such dispersal.

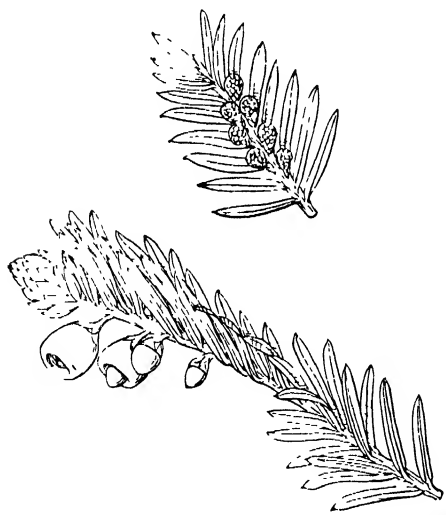
To get rid of this pest, drainage and manuring are helpful A topdressing of salt applied about the end of April at the rate of 6 cwt. per acre may prove effective. It must be remembered, however, that the salt acts injuriously upon the grass, at least for a time. In hay meadows, mowing should take place early, so that the Yellow Rattle can scatter no seed. If this is done for two or three years in succession, the weed is bound to disappear.

[A. N. M'A.]

Yellow Underwing, a brownish or tawny-coloured moth, the parent of a surface grub which is very destructive to cabbages and turnips See TRIPHLENA PRONUBA.

Yellow Vetchling. See LATHYRUS

Yew (TAXUS), originally classed as a genus of the Coniferæ and then formed into the only



Yew (*Taxus baccata*)

family of a nat. ord. *Pseudodrupaceæ*, has again been included among the Conifers as the Taxeæ tribe, including the genera Taxus, Gingko, and Dacrydium Although there are at least six sub-species and several varieties, there is only one true species, the Common Yew (*T. baccata*), which extends throughout the temperate and warmer regions of the Northern Hemisphere, and the mountainous regions of the Tropics at from 5000 to 11,000 ft elevation It is a slow-growing and very long-lived small tree or shrub (some of those in Europe being said to be from 2000 to 3000 years old), with smooth, thin, reddish-grey bark, peeling off in longitudinal shreds, and hard and even-grained heartwood varying in colour from reddish-brown to orange-red, light red or white, and weighing from 45 to 55 lb. per cubic foot (used for cabinetmaking). Its foliage is dark-green, the leaves being flat, linear, distichous, 1 to 1½ in. long, 1-nerved, narrowing into a very short petiole, and without any resin canal. The flowers are dioecious, on short axillary branchlets densely clothed with imbricating bracts. The male flowers are pedicelled and sub-globose, with numerous peltate scales, each bearing 3 to 6 anther-cells on the under side, while the female is a simple erect ovule surrounded at the base by a disk that is membranous in the flower, but in the fruit (ripening in autumn) enlarges into a red fleshy cup, enclosing a seed with hard testa, which germinates with two thick fleshy cotyledons In ancient day Yew was of importance as furnishing the best bows for archers, and in England Yews planted in churchyards received legal protection early in the 14th century Probably the oldest Yew in Britain is that in Crowhurst Churchyard (Sussex), which still produces seed plentifully; one of the largest (30 ft. girth at 4½ ft. up) is in the deer park at Knutchinch (Hereford) Probably the largest in Scotland is at Craigends in Renfrewshire, girth over 20 ft., another at Rossdhu (Dumbarton), in 1891 was 40 ft high and girthed 13 ft at 5 ft up while many fine specimens of the Common Yew and Irish Yew are to be found in Ireland The seeds lie dormant for a year, and may therefore be washed free of pulp and stored in sand before sowing in the second spring after ripening, while varieties are propagated by cuttings Yew grows best on a limy soil and in a damp locality and has great power of enduring shade It stands clipping well, and is therefore suited for hedges and topiary gardening, but its foliage is poisonous to horses and cattle See POISONOUS PLANTS [J. N.]

Yew Midge. See CECIDOMYIA TAXI and DASYNEURA TAXI

Y-Moth, a beautiful silvery-coloured moth whose larvæ are occasionally destructive to root crops See PLUSIA

Yoke and Yoking.—A yoke is a frame of wood fixed with bows over the necks of oxen

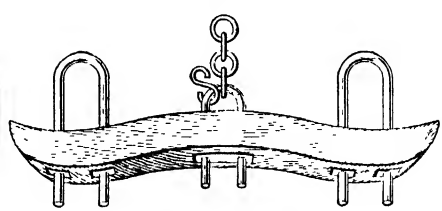


Fig 1.—Bullock Yoke

whereby they are coupled together and harnessed to the plough The term is also applied to a somewhat similar contrivance carried on a man's shoulders, from either end of which is a chain to which a bucket can be attached, thus relieving the man's arms from the strain of the load A yoke of land is the area which two cattle under the yoke can plough in a day Yoking is now applied in the broader sense of the operation of putting horses as well as cattle into the team. The use of bullocks for purposes of draught has almost died out in this country, and there appears to be little likelihood of its revival. Very considerable variations in harnessing and yoking of cattle prevailed, as they do in other countries

to-day: the draught being variously taken from the shoulder, from the neck and shoulder conjointly, from the head or forehead.

Yoking, or the method of harnessing horses to their work, is done in many ways The draught is always taken from the shoulder from hames embracing the collar, except where a breast collar

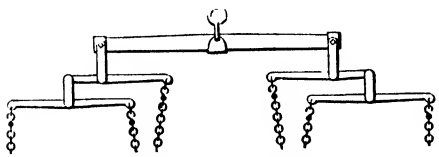


Fig 2 —Three Horse Whipple-trees

is used. The hames are supplied with hooks or chains to be coupled up to the implement, though for some kinds of work leather traces are used, leather, however, does not readily admit fore horses to be hitched on to it, consequently it is not used for the general purposes of the farm, chains being more convenient. In shaft work,

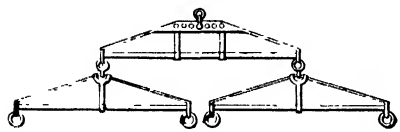


Fig 3 Trussed Beam Whipple trees with adjustment to adapt draught to number and strength of horses

short chains from the hames are hooked to hooks suitably placed on the shafts, or by long traces attached to the rear end of the shaft Horses with chains used in front of the shaft horses are attached to rings on the shafts Where poles are used in the place of shafts no saddle is needed, the weight being carried by straps from the collar to a cross-bar or pommel at the end of the pole, the draught is taken by long chains

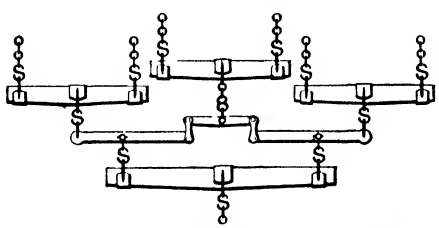


Fig 4 —Three-horse Compensating Whipple-trees

or traces. If a fore horse is needed it is hooked on to a whipple from the front end of the shaft. More ingenuity is required where horses are worked entirely in chains attached to whipple-trees or swingle-trees, and the design of the swingle-trees bears considerably on this When horses are abreast, each (apart from special device to make the draught unequal) takes an equal draught, whether there be two or more horses; and there is no doubt that horses are able to work with greater effect and ease in this form than in any other. When two are abreast and one in front (unicorn), the fore horse is attached in several ways. It may be

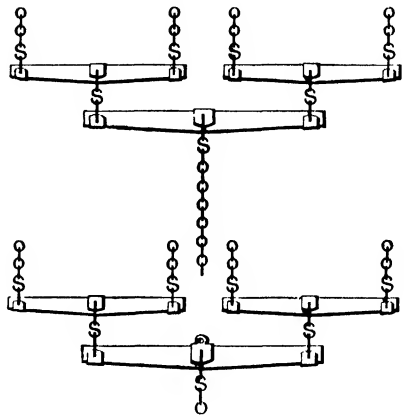


Fig 5 – Four-horse, two pairs abreast, Double Sets of Whipple-trees the front being yoked through medium of long draught chain. Collar chains help to uphold the chain.

by fore chains with stretch-stick hooked into the hind or phill horse's chains well behind the hames, by a separate draught chain attached to the main swingle-tree or pommel, passing between the two hind horses, in which case a light whipple is placed at the end of the draught chain (this is more convenient for cultivating and similar work than for plough, though the horse may be trained to walk outside the furrow); it tends to even draught, though a compensating set of swingle-trees will also effect this. Where horses are worked in single file, which is the most wasteful method of yoking, but not uncommon in ploughing on heavy land, the rear horse is known as the phill horse, the next as the body horse, the next the middle, and the front as the fore horse or leader. The three leading horses are supplied with fore chains and stretch-sticks, the chains being hooked back. Wherever a fore horse is used, the hinder horse's chains should be fitted with a stout ring link, and in front

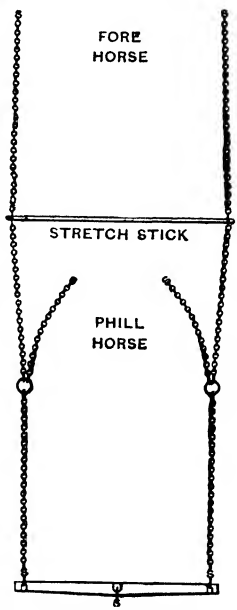
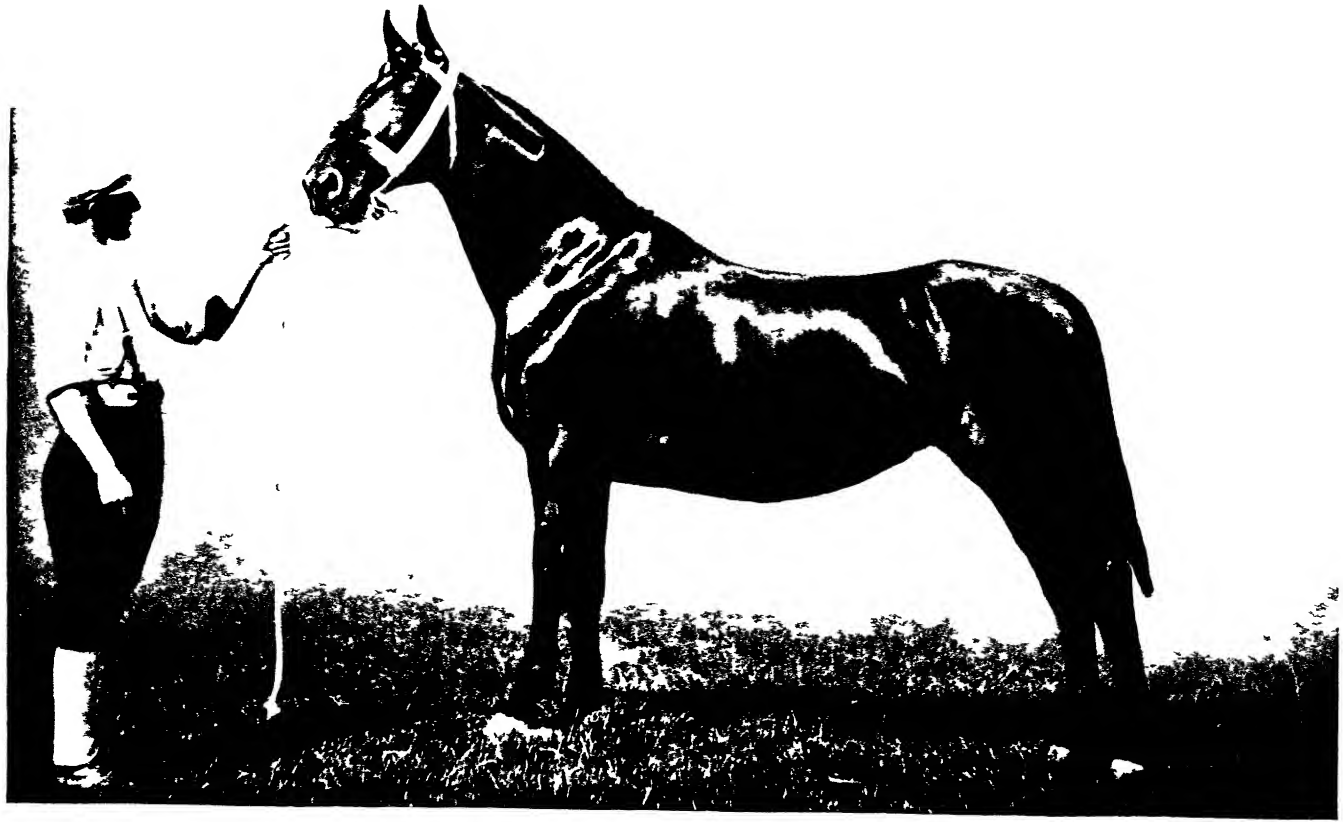


Fig 6 —Single Work in Tandem



of this the chain should be continued in two lengths about 2 ft. long, one to be attached to the hinder horse's hames, and the other to receive the fore-horse chains. In this way a better line of draught is made. If the fore horse is coupled close to the hames of the hind horse, there may be great loss of pull. Sometimes double chains from the swingle-tree to the fore chains are used, but there are inconveniences associated with this which are not compensated for by any increase in draught [W. J. M.]

Yorkshire Coach Horse.—The special breed of horses generally denoted as the Yorkshire Coach Horse has been known in the county from which it takes its name for at least three hundred years, though it is only for the last century that special attention has been paid to the development of the particular characteristics which distinguish it from the Cleveland Bay. If the two did not have a common origin—and authorities differ on the point—at least the terms have been more or less interchangeable for generations. As a specific breed the Yorkshire Coach Horse has been cultivated since the middle of the 18th century, and many of the animals then known in the county traced their descent back to notable Arab sires. Among the more famous of these was the Helmsley Turk, while from the beginning of the 17th century Arabian sires, both Barbs and Egyptians, have left their stamp on a large progeny over the North and East Ridings. The mating of these stallions with the powerful and active native mares of the locality has undoubtedly produced a refinement of the local type, combining the power and size of the maternal ancestors with the superior activity and lightness of the sire. A process of careful selection and continuous cultivation has produced the breed as we now know it, and it is unlikely to have been the result of the fortuitous crossings between Thoroughbreds and heavy cart mares which some authorities suggest. The close relationship of the Coach Horse with the Cleveland Bay, a hundred years ago, probably arose from the fact that the early coaches were nearly always horsed by the Cleveland Bay breed, later developments in locomotion, the improved road surfaces, the lighter and less cumbrous vehicles, the demand for accelerated speed, all combined to create a demand for an animal which should combine the characteristics of the Cleveland with some of the proportions of the Blood Horse. This happy combination is, in the view of the Yorkshire Coach-horse breeder, to be found in that distinctive breed which takes its name from the county of broad acres.

While the Cleveland Bay is almost exclusively found in the north-east corner of Yorkshire, known as Cleveland, the Coach Horse is fairly evenly distributed over both the North and East Ridings of Yorkshire, many of the principal breeders raising both types. The great East Riding district of Howdenshire is the chief breeding ground, though they may be met with in Buckrose, Holderness, Ryedale, and up in the dales which stretch on each bank of the Derwent. They are also to be found occasionally in Cumberland, in Northumberland, and in Lincolnshire; and one or two gentlemen who make a study of the breeding of a fine and elegant type of carriage horse have studs in the south of England.

The special characteristics of the breed are symmetry of form, fine texture of skin, uniformity of coloration—a factor greatly enhancing their value as carriage horses—speed, power, endurance. The first three mentioned qualities are possessed in equal degree by the Cleveland Bay, but while this horse is capable of heavier work than the Coach Horse, *the latter has an elegance and grace of carriage, and an additional speed, not equalled by the Cleveland.* The *Stud Book* lays down as the essential qualities of the breed 'By universal consent the colour should be bay or brown with black legs, mane and tail abundant but not curly; in height from 16 hands to 16 hands 2 in., with fine head, sloping shoulders, strong loins and lengthy quarters, high stepping action, good sound feet, flat legs and abundance of bone and muscle for any effort that may be required of them'. The Yorkshire Coach Horse is a particularly handsome animal, and the fact that he never varies in colour renders him additionally valuable for the main purpose for which he is employed—a high-class carriage horse. In the Royal stud are several magnificent specimens of the Yorkshire Coach Horse, 16·2 hands high, animals quite unapproachable for stately dignity and power. His slightly Roman nose, well-poised, fine head, gracefully arched neck, and well-proportioned body render him practically unmatched as a carriage horse.

They are occasionally ridden to hounds, though not so frequently as formerly. As a foundation breed for a Hunter the Coach Horse is valuable, a first cross with a Blood Horse producing a bold and fearless Hunter. While it cannot be compared with the Cleveland as a general-utility horse, blood mares, not intended for show purposes, make excellent farm horses, and are generally employed on the light-land Wold dale farms for ploughing and the other processes of agriculture, as well as for draught purposes on small estates. The small Wold farmer finds the Coach Horse a very profitable animal, and a farmer with half a dozen mares working his land finds himself better off than his neighbour employing the heavier cart horse.

The increasing favour with which the Hackney has been regarded in some circles as a carriage horse has had the effect of somewhat reducing the demand for the Coach Horse in the home market, and the breed does not enjoy the same popular favour as it did forty years ago, when it was in great demand. Signs are not wanting, however, that it will be used extensively as the foundation breed for troopers and the mounted batteries of the artillery. Wherever a demand exists, too, for the best style of carriage horse it will be inevitably in request. Abroad its splendid qualities have long been recognized; and though the demand for sires and mares abroad varies in different countries from time to time, there has for long been a steady foreign market. Originally the United States of America was among the best cus-

tomers, and there is now an American Yorkshire Coach Horse Stud Book, in which all the English horses exported to the States are eligible for inclusion on presentation of their registration at home. As illustrating the peculiarly impressive character of the Yorkshire coaching sire, it may be mentioned that in Texas, where coaching stallions have been largely used, the native mares are invariably dun-coloured, yet fully 90 per cent of the progeny of the native mare mated to a coaching sire are true to the bay colour of the stallion. A few mares and stallions have been exported to the Argentine. Five mares were recently sent to Buenos Ayres, the highest price realized being £850. California was a former customer. To-day Chile, Canada, South Africa, India, and Japan are the principal importers outside Europe. For twenty years there has been a steady demand for the Yorkshire pedigree Coach Horse in Natal, Cape Colony, and the Orange River Colony, where the Agricultural Department have a few stallions. In India the Coach Horse deteriorates in size, and practically in every country abroad there is a tendency for the breed to soften and exhaust itself. In Austria, Italy, Russia (among the best of modern customers), Bavaria, Holland, Spain, it is always the same story. The true type can, happily for the English breeder, who is usually a tenant farmer, only be maintained in England, and in twenty years foreign breeders were compelled to come back to England for an infusion of fresh blood and bone, to reinforce from the pedigree studs. The precise reason for this deterioration abroad is not clear, though various ingenious explanations have been offered, and there can be no doubt that climatic conditions are in some way responsible for the phenomenon. The especial care and attention which has been bestowed on preserving the purity of the breed in England, too, has not been without definite influence on the result.

It is difficult to estimate the exact number of Coach Horses at present in the country. The Yorkshire Coach Horse Society will admit into its book Coach Horses with two crosses, though the Cleveland Society will not admit any but pure-bred Clevelands, so that though Clevelands are eligible for the Coach Horse Society's book, the converse does not apply. In this way the Yorkshire Coach Horse maintains the strength and substance derived from the Cleveland. The record of the stallions entered in the first edition of the Stud Book goes back in several instances to the early 'twenties of the 19th century, and in a few cases anterior to that. The Society was formed in 1887, and there were registered up to 1908 approximately some 2500 stallions and 1150 mares.

Systematic records do not appear to have been kept of the prices realized either in the home market or for export. Probably the top price for a stallion in the present state of the market would be 300 gs., though they have realized as much as a thousand. The average price of a two-year-old stallion to-day is about 260 gs. and a mare 175 gs. Geldings sold as harness horses at four years old realize from 80 gs. to 100 gs., and mares from 60 gs. upwards. For the famous stallion Sultan Mr. Burdett Coutts refused 1000 gs.; Landmark, foaled in 1870, was sold to the King of Bavaria for 400 gs.; Necromancer, sire of Sir Edmund, sold for £600 to go abroad; Don Quixote, a son of Necromancer, realized £500, and Burton's Eloi sold for 500 gs. Among other famous horses was Dreadnought, which travelled in 1829 and won a match for £100, trotting sixteen miles within the hour carrying 16 st., and was finally sold to go abroad for 400 gs.

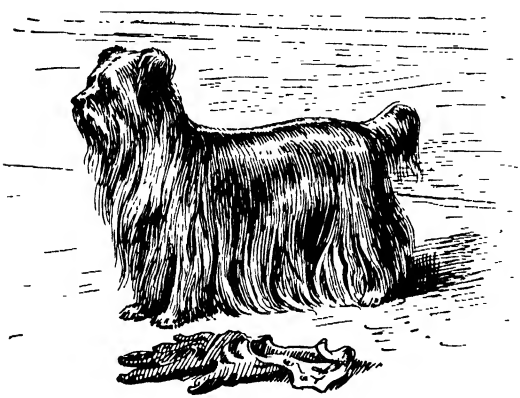
The Coach Horse is largely bred by small farmers, many of whom possess one or two brood mares of the right stamp, and engage in the breeding of Coach Horses as a subsidiary occupation to their general farming. Breeders on at all a large scale are comparatively few in number; among the chief names are those of Mr. George Scoby, Beadlam Grange, Norton, Helmsley, Mr. F. H. Stericker, Pickering, Mr. J. Lett, Rillington; Mr. J. W. Lett, Welham; Mr. Silvester Leaf, Escrick; Mr. J. Beckett, Deighton, York, Mr. F. P. Baker, Ingmanthorpe, Mr. George Grandage, Yeadon, Bradford, Mr. W. Petch, Pocklington; Mr. W. Johnson, Hook, Goole; Mr. G. Burton, Thorpe Willoughby, Selby; Mr. C. H. Hart, Appletree Farm, Selby; Sir Walter Gilbey, Mr. C. Harrison, Bossall, York, Lord Wenlock, Escrick; Mr. J. Jebson, Pocklington, Mr. George Elders, Aislaby. Mr. B. Kitching, Pickering, Mr. A. Moscrop, Marske-by-the-Sea, Mr. J. H. Tyreman, Hinderwell, Mr. Slater, Harome, Norton, York, Mr. Goodericke, Mr. T. Leefe, Slingsby.

Formerly the Coach Horse was sold in large numbers at the famous horse fair at Howden in the East Riding, at York Christmas horse fair, and at Northallerton, Yarm, Guisborough, and Stokesley in the North Riding. To-day comparatively few Coach Horses find their way to the annual horse fairs in Yorkshire—there is still, of course, a sprinkling, but the general practice is for agents of purchasers acting for foreign buyers or for the Army Remount Department to make periodical tours through the Coach Horse districts in Yorkshire—fairly well-defined geographical areas—and to select what they require. The Coach Horse classes at the Royal and Yorkshire shows, as well as some of the larger shows of secondary importance, also afford excellent opportunities of seeing the best representatives of the breed in the showing, and of making any selections for purchasers; though many of the small farmers who are breeders of consistently good stock are unable to bear the cost incidental to showing at other than purely local events, and many an excellent animal of the true stamp and with famous strains is to be found on some of the remote Yorkshire farms. [W. S.]

Yorkshire Pigs. See LARGE WHITE PIGS; MIDDLE WHITE PIGS.

Yorkshire Terrier.—In the opinion of many persons the Yorkshire Terrier is the most beautiful dog in existence, the silver and gold coat he possesses being a subject of admiration even amongst those who are not enthusiasts in their devotion to the canine race. On the other

hand, the breed possesses no claims to be regarded as a sporting variety in any sense of the word, as it is of a delicate constitution, and its silken jacket is not adapted to resist the attacks of rain or thorns. As a consequence the Yorkshire Terrier must be regarded as a Toy variety pure and simple, and in this connection a very valuable one. The chief point that is sought for is the development of coat, which must be long, free from curl, silky in texture, and of the correct shades of colour. The latter consist of rich golden tan on the face and feet and ears, the latter being of a rather deeper shade than on the face, whilst the hair on these parts is much shorter than on the rest of the body. The prevailing colour is a beautiful silvery-grey, rather darker on the back and sides than elsewhere, and the coat is so long that in the case



Yorkshire Terrier

of a good specimen it almost trails along the ground. It is very profuse on the head, too, in fact so much so, that it is the custom of breeders to tie the hair back and fasten it with ribbon so that the dog is able to see. It may be added that the puppies of this breed are born black-and-tan in colour, the desired shade of coat being acquired later on. As may be supposed, the care of their dogs' coats is a constant source of trouble to owners, whose practice it is to keep the animal's feet tied up in wash-leather bags to prevent their scratching the hair, which is frequently dressed with cocoanut oil in order to stimulate its growth. A peculiarity of the Yorkshire Terrier is that it is, like the Bedlington, a flat-sided breed, but in other respects there is nothing peculiarly characteristic in connection with its conformation, which is practically concealed by its coat. Its head, however, should be flat, the muzzle rather long and delicate, and the fore legs long and perfectly straight; whilst it is the usual practice to dock the tail short. The weight of this breed varies from 12 lb. to 8 lb., the smaller dogs being far the most valuable, provided that they possess the desired points. [V. S.]

Youatt, William, an eminent veterinary surgeon of the first half of the 19th century, best known as the editor of the comprehensive work on agriculture entitled The Complete Grazier. Youatt was the son of a surgeon at Exeter, and was born in 1776. He was educated for the Nonconformist ministry, but came to London in 1810 to join a veterinary surgeon, D. P. Blaine, in conducting a veterinary infirmary in Wells Street, Oxford Street. After twelve years this business passed into Youatt's hands. In 1828 he began to deliver a series of lectures and demonstrations to veterinary students at his infirmary, designed to supplement the teaching of the Royal Veterinary College. These lectures were later on delivered at the London University. In 1835 they were abandoned, but Youatt continued for four years to print a monthly series of written lectures in the Veterinarian, a professional monthly which he started in 1828. In 1838, when the Royal Agricultural Society was founded, Youatt became one of the original members. He was evidently regarded as being at the head of his profession. In 1830 he was commissioned to write a series of handbooks on the breeds and diseases of the various farm animals, and these were issued in parts under the various titles, Cattle, Sheep, The Horse, and The Pig. He died in 1847. As there is no evidence in the meagre available information as to Youatt's life-history of his means of obtaining the intimate knowledge of farming details shown in The Complete Grazier, it must be assumed that he was assisted in it by contributors, including men of scientific attainments, as well as experts in the practice of agriculture. [W. R. B.]

Young, Arthur. The most famous writer on agriculture that the world has seen, and one of the most unsuccessful of farmers, was born at Whitehall, London, on September 11, 1741. He was a member of an old Suffolk family. His father was Dr. Arthur Young, a clergyman. In his boyhood he was sent to Lavenham School, a selection which he always regarded as a great mistake, seeing that the famous school of Bury St. Edmunds was near to the family residence at Bradfield. When he was seventeen years old he left school, and was apprenticed for three years to a firm of merchants at Lynn, in Norfolk. In his Autobiography, edited by Miss Betham-Edwards (Smith, Elder, & Co., London), from which the facts of this condensed memoir are taken, Young expresses regret at the selection of a mercantile career for him, as entirely uncongenial. At the end of his apprenticeship, when he was twenty years old, Young was at a loss for a career. Dissuaded by his mother from entering the army, he decided, at her request, to take the home farm of 80 acres at Bradfield into his hands, with a second farm that had been occupied by a tenant. Starting in 1763, Young farmed for four years, during which period, he says, he acquired a little knowledge of farming, the chief use of which was to

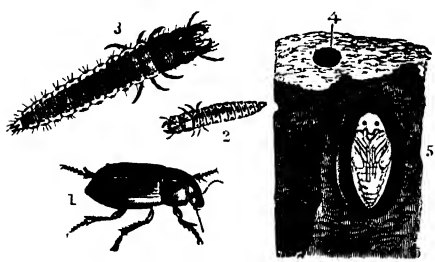
enable him to view the practice of other farmers with some discrimination. In 1765 Young married a daughter of Alderman Allen, of Lynn. In 1767 he entered upon what he describes as the fine farm of Samford Hall, in Essex. His capital was quite insufficient for his undertaking, and at the end of six months he had to give up the farm. In the same year he commenced his famous set of tours through the agricultural divisions of England, starting with the southern tour. This was followed by the northern tour in 1768, and by the eastern tour in 1770. It is hardly necessary to state that the reports of his tours excited the greatest interest in the country, for Young was as keen as an observer and as eloquent as a writer, as he was incompetent as a farmer. In 1768 a third venture in farming was made at North Mimms, Hertfordshire, but again without success. In that year he published 'A Farmer's Letters,' which reached a second edition. In 1772 Young published his 'Political Essays on the British Empire,' and 'Present State of Waste Lands.' His prolonged financial difficulties had preyed upon a mind disposed to hypochondria, and he had serious thoughts of ending his career in England, and emigrating to America. In 1773 Young became Parliamentary reporter to the 'Morning Post,' and for a time he was relieved from an almost destitute condition. Apparently he held this position for two years. At every week-end he walked seventeen miles to his farm at North Mimms. In 1774 he published his 'Political Arithmetic,' a successful work which was translated into many languages. He had become famous from his writings, and at about this time he was elected a Fellow of the Royal Society, and an honorary member of the Palatine Society of Agriculture at Mannheim and of the Geographical Society of Florence. The Irish tour was carried out in 1776. In the following year the first piece of considerable good fortune that Young enjoyed came in the form of his appointment as resident agent on the Irish estate of Lord Kingsborough, at a salary of £500 a year, a house rent-free, and a retaining fee of £500. Young then disposed of the lease of his Hertfordshire farm, and went to reside at Mitchelstown, Co. Cork. His good fortune, however, lasted for only a year, a conspiracy to substitute another man in his position having led to the termination of his agency in consideration of a life annuity of £72 per annum being guaranteed to him. In 1778 he went back to live with his mother at Bradfield, where he once more engaged in farming on his own account. In 1783 Young began the publication of his 'Annals of Agriculture,' which increased his fame, but afforded no profit. In 1785, on the death of his mother, he inherited the Bradfield estate. In the following year he made his westerly tour, and a year later his immortal tour in France, repeated twice in subsequent years, the last being 1789. In 1789 he also visited Italy. In 1793 the original Board of Agriculture was established, with Sir John Sinclair as president, and Young was appointed secretary. He was far from being satisfied with the arrangements or the remuneration, and one of his complaints was that the President appointed men who 'did not know one end of a plough from the other' to make county surveys. In 1797 Young suffered the calamity of the death of his beloved daughter, Bobbin, at the early age of fourteen years, and from that time forward his dejection deepened. This, largely as the result of his acquaintance with Wilberforce, developed into confirmed religious melancholia.

Young was one of the most censorious, as well as one of the most discontented of men, and he did not take kindly to superintendence. He was constantly grumbling at the action of Sir John Sinclair, but apparently he was not any better pleased with succeeding presidents, Lord Somerville and Lord Carrington. Similarly, when he attended the great sheep-shearing gatherings or other functions in which lavish hospitality was shown by great landowners, he poured into his diary a flood of sanctimonious censoriousness of the most offensive character. It may be assumed that the Arthur Young of public and social life was an entirely different man from the author of the Autobiography, or he would not have held his official position so long as he occupied it, or have been courted as a companion and guest by the greatest men in the country. He would dine sumptuously with a host, and then lament in his diary that it was bad for his soul, or mere dissipation. Towards the end of his life Arthur Young gradually became blind. Most of his time was spent at Bradfield, where his benevolent exertions for the welfare of the poor in his own and neighbouring parishes endeared him to the people. He died on April 20, 1820, in the 79th year of his age, and was buried in Bradfield churchyard. The value of the arduous work for the benefit of agriculture which he carried out in the course of his long life cannot be too highly appreciated. [W. E. B.]

Yucca (Adam's Needle, Bear's Grass, Spanish Bayonet), a genus of Liliaceæ, natives of the Southern United States, Mexico, and Central America, the hardy species of which are very striking and useful garden plants. Some of them form stems 6 ft. to 10 ft. high. The leaves are long and sword-shaped, and the large, white, bell-shaped flowers are borne in large, much-branched panicles. They appear to best advantage when grown in isolated groups, and prefer a well-drained loamy soil and a sunny position. They are propagated by division, being planted in the open ground, or by cuttings of the fleshy roots inserted in sandy soil in heat. They usually flower in a warm season, but rarely ripen seeds in this country. The more tender species may be brought out-of-doors with good effect in summertime. The hardy sorts most cultivated are *Y. angustifolia*, of small habit, with narrow leaves, and early flowering; *Y. gloriosa* (Adam's Needle), the hardiest and freest flowering, of stiff upright habit, with large leaves, and inflorescences 4 ft. or more high; and *Y. recurvifolia*, much like *Y. gloriosa*, but with semi-pendant leaves. Some other species are well adapted for outdoor cultivation in warm localities. Some of the Yuccas attain very large dimensions, and their fibre is used in the manufacture of coarse cloth and cordage. [W. W.]

Z

Zabrus gibbus, Fab. (Corn Ground Beetle) —Though a member of the carnivorous family Carabidæ, *Z gibbus* is an exception, for both the larva and beetle feed upon corn crops. The appearance of the insect may best be gathered from the accompanying fig. It is found in England, but its chief ravages have hitherto occurred on the Continent, and especially in Germany Clusters of eggs are deposited by the female in the earth, the larvæ



Corn Ground Beetle (*Zabrus gibbus*)

1, Female, slightly magnified 2, Larva 3, Larva magnified. 4, Burrow 5, Pupa

from which live for three years, during which they excavate perpendicular and curved burrows in the earth, from a few inches to 2 ft in depth, and then about the beginning of June form oval cells, in which they change to whitish pupæ with dark eyes.

In Saxony the larvæ have destroyed two sowings of wheat, and then attacked the rye and barley They come out at night, and eat into the stems of corn close to the surface, to feed on the pith. The beetles afterwards make their appearance in enormous quantities, concealing themselves under clods by day, and at night ascending the stems to feed upon the soft grain. The pest confines its attacks to cereal crops, and is best combated by an adequate system of rotation. [J. C.] [C. W.]

Zea, the botanical name for maize. See MAIZE.

Zebra is a term comprehensively applied to the striped wild members of the Horse tribe (Equidæ). They resemble donkeys, and differ from typical horses in having a hog mane, a tufted tail, and callosities or chestnuts only on the fore legs. From donkeys zebras may be collectively distinguished by possessing stripes at least upon the head, neck, and shoulders; but apart from this character, the four existing species, which are confined to the continent of Africa, have very little in common, differing markedly from each other in the pattern or arrangement of the stripes, the size of the ears and callosities, and other structural features. These four species are: Quaggas (*Equus quagga*); Mountain Zebras (*Equus zebra*); Foa's Zebra (*Equus foai*); Grévy's Zebra (*Equus grêvyi*). Quaggas (*E. quagga*) have a wide range. They extend from southern Abyssinia to South Africa, and were formerly abundant upon the flats close to Cape Town. They are more horselike in build and proportions than the other species, and are adapted to a life on the plains or elevated plateaus In the north and eastern districts of their range as far south as Mashonaland, they are fully striped, the stripes passing to the middle line of the belly and down the legs to the hoofs. The peculiarity of the pattern consists in the backward inclination of the upper extremities of all the stripes in the posterior half of the body This is seen in all existing races of Quaggas; but in some of the extinct races that formerly existed in Cape Colony the stripes over the hindquarters were evanescent, so that the characteristic arrangement above described can at most be only dimly discovered on the few mounted specimens preserved in museums Nevertheless these southern races are connected with the fully striped northern races by various intermediate types, the best known of which is Burchell's Quagga (*E quagga burchelli*), which formerly occurred in Bechuanaland, but is now nearly extinct In this form the belly and legs almost up to the shoulder and croup are stripeless or weakly striped, and there are numerous narrow intermediate stripes between the broad main stripes Further evidence that the extinct Quaggas belonged to the same variable species as the more northern forms is found in the shape of the hoofs, the medium-sized ears and callosities, and lastly by similarity of voice, the cry much resembling a shrill, quickly repeated bark, which has been represented by the syllables qua-ha-ha It is from their cry that the Quaggas take their name.

Standing about 11 hands at the withers, and therefore smaller than Quaggas, which are about 12 hands, the Mountain Zebra (*Equus zebra*) further differs from them in having large asinine ears, a very narrow high hoof, adapted for mountain climbing, a lappet of skin on the throat, and the hairs along the spine growing forwards. The stripes, moreover, are numerous, except on the quarters, where they are very wide, and only two stripes from the croup pass on to the flanks in front of the stifle. The summit of the croup is marked with numerous short crossbars, constituting the so-called 'gridiron' pattern. Formerly abundant in the mountains of Cape Colony, this zebra is now approaching extinction in that area; but the species still exists in a wild state in Angola and German S.-W. Africa.

Still more restricted in range than the Mountain Zebra is the little-known Foa's Zebra (*E. foai*), which lives in the mountains of Nyasaland. It is a fully and closely striped species, resembling the Quaggas in most structural characters, but differs in that the flank stripes assume dorsally a backward trend only just in front of the croup.

The largest and handsomest but the most clumsily built of all zebras is the Abyssinian

and Somaliland species, named after President Grévy (*E. grévyi*). The head is long, the neck short, and the ears are long and expanded towards their tips. The stripes are very numerous and close-set; the spinal stripe is wide, and none of the stripes on the body turn backwards on to the croup, the upper part of which is marked with vertical stripes extending some distance down the thighs. This zebra stands about 12 hands, and although only made known to science in the latter half of the 18th century, is no doubt the *hippotigris* or 'tiger-horse' of the Roman circus. The voice of this zebra is an unmistakable bray, and shows closer kinship between this species and African asses than exists between it and Quaggas. It has much the same habits as Quaggas, and where the ranges of the two species cross, they may sometimes be found together.

No zebras are untamable so far as is known, members of all the species, with the exception of Foa's Zebra, having been broken to harness, either for riding or driving. They are not, however, equal to horses or mules in strength, endurance, and docility, and no serious attempt has ever been made to domesticate them for man's use. Hybrids have been obtained between Mountain Zebras and Quaggas and ponies and asses. The cross between bay ponies and Quaggas, called Zebruler and Zebrinner, are beautiful well-made animals, showing faint and narrow stripes on a bay ground, the mane and 'points' being black. It was thought at one time that they might prove useful for work in the Tropics, where horses do not thrive; but, like mules, they are sterile, and are never, therefore, likely to supersede that animal, which is unrivalled for draught work under conditions unsuitable for horses. [R. I. P.]

Zebu is the common English name for the Indian Humped Cattle (*Bos indicus*), which, like European breeds, are only known as domesticated animals. In several points, such as the shape of the horns, the presence of a large fatty and fleshy hump upon the shoulder and of a deep dewlap on the throat and breast, as well as the voice, which is a grunt rather than a bellow, zebus differ from ordinary European cattle; and there is no doubt that the two are descended from distinct wild, but now extinct, stocks. The numerous breeds that are recognized in India are referable to two main types. One type, of which the Guzerat and Hissar breeds may be cited as examples, has large pendulous ears, a flatter forehead, and horns arising at the sides of the head and curling outwards and upwards. The other type, represented by the Mysore breed, has the ears much smaller, and not pendulous, the forehead rounder, and the long, tapering, lightly curved horns rising close together on the summit of the head and running backwards nearly in the plane of the face. In both these breeds the most fancied colours are iron-grey or black for the bulls and nearly white for the cows; but all sorts of colour varieties are met with where selective breeding has been neglected. Some zebus, especially of the northern breeds, are large handsome animals exceeding European cattle in height; but dwarfed breeds are not uncommon, some specimens standing no higher at the shoulder than a large dog. As a rule, horns are present in both sexes, those of the cow being smaller; but hornless varieties of Zebu are known; and formerly at all events there was a two-humped variety, which was most common in Surat. Humped Cattle, when not sacred, are used in India for ploughing and heavy transport of various kinds, also in military service for gun-carriages. They are strong and, comparatively speaking, active animals; and when employed for riding or light carriage-work are capable of travelling thirty miles a day. They are able to withstand tropical heat much better than European cattle; and the recent importation of specimens for work in certain parts of South America where ordinary cattle do not thrive, has hitherto met with promising success. Humped Cattle long ago made their way into Madagascar and Africa, penetrating in the latter country as far as Nigeria and Cape Colony; and it is believed that traces of their blood are to be detected in some of the cattle of South Europe. The exact relationship between the Indian zebus and some small-humped, very large-horned breeds from Gallaland, the Eastern Sudan, and elsewhere is not clearly understood. Some authors suppose the latter to be merely localized varieties of the ordinary Humped Cattle, while others regard them as being the descendants of another species, now extinct, to which the name *Bos ægyptiacus* has been given. [R. I. P.]

Zeolites, the name of a group of hydrous silicates, commonly derived from the alteration of felspars or the allied minerals styled felspathoids, or even of the glassy ground of volcanic rocks. They may develop in the hollows of lavas, or within the parent minerals, soon after the igneous mass has begun to cool down, or perhaps long subsequently. In either case, their production is due to the permeation of the rock by volcanic waters, and it is claimed that one zeolite, analcime, arises as a primary constituent, retaining some of the original water of the mass. Zeolites are usually colourless or white, more rarely yellowish or red. They occur for the most part as needle-like crystals, forming aggregates in the decomposing minerals or in the hollows of the igneous rock. As a rule, they fuse easily before the blowpipe, and some boil up or intumesce during heating, much like borax. They are silicates of aluminium, with potassium, sodium, calcium, or barium, and with water, which essentially marks them off from the felspars. The following examples illustrate their constitution and their varied systems of crystallization:—

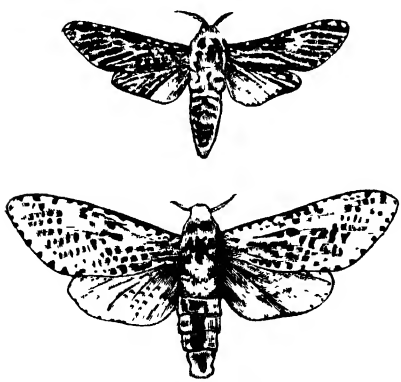
Natrolite. $Na_2Al_2Si_3O_{10} + 2H_2O$. Rhombic.
Analcime. $NaAl(SiO_3)_2 + H_2O$. Cubic.
Stilbite $(Na_2,Ca)Al_2Si_6O_{16} + 6H_2O$. Monoclinic.
Harmotome. $H_2(K_2,Ba)Al_2(SiO_3)_5 + 4H_2O$. Monoclinic.

The mode of combination of the water is in some cases still a matter of discussion, and a certain instability in the molecules of zeolites no doubt permits them to play an important part in transferring substances like calcium and

potassium in an available condition into the soil. Owing to the researches of Lemberg in 1885 and 1887, it has been suggested (Hilgard, Soils, 1906, p. 37, and Hall, The Soil, 1908, pp. 25, 39, and 214) that small quantities of zeolites occur in ordinary clays, and that the alkali which they contain, when it is set free, prevents fine clay from flocculating (see art. Flocculation). The fact that ammonium and potassium are fixed by soils from compounds in solution is attributed in part to the decomposition of zeolites and to the substitution of these substances for sodium or calcium. Solutions, it is urged, may also liberate potassium. G. P. Merrill has discussed this matter from the geological point of view (Rocks, Rock-weathering, and Soils, 1906, p. 363), and concludes that the presence of zeolites in soils has not been proved. Their mode of occurrence in nature is limited, and they are not a common result of mere superficial weathering. On the other hand, where altered basalts, andesites, and phonolites furnish the materials of a soil, zeolites may have already arisen from the felspars and their allies in these rocks, and will naturally abound throughout the soil. Their easy decomposition by acids then allows of the transference of materials to the soil, which are too often locked up in felspars or rock-fragments that yield them very slowly.

[G. A. J. C.]

Zeuzera pyrina (or *Z. aesculi*), the Wood Leopard Moth, is a prettily marked insect, with



Wood Leopard Moth (*Zeuzera pyrina*). Male and female.

blue-black spots on a white ground, which does considerable harm on account of the wood-boring habits of its caterpillars. The dark-yellow eggs are laid in crannies of the bark during the summer, and the larvæ tunnel in the hard wood, where they feed for about ten months, after which they turn to chrysalids under the bark. Many different trees are attacked, but in England fruit trees suffer most, and more injury is usually done to the smaller branches than to the main trunk. Often no hole is visible, and the cause of injury is only discovered by cutting open the dying branch. Where holes are observed, pieces of stick cyanide of potassium may be introduced and the orifice plugged up, as in the treatment for Goat Moth (see Cossus); but if the smaller branches of a fruit tree are seen to be dying without obvious cause, they should be cut off and the caterpillar sought for and destroyed if present.

[C. W.]

Zoology (Agricultural).—Animals are in many different ways bound up with the business of agriculture, and a study of them in this connection is somewhat awkwardly termed 'Agricultural Zoology'. In illustration of this it may be useful to give a brief statement of the chief practical relations between animals and agriculture, and of the main problems which these relations involve. (1) Domesticated animals are bred for what they produce when alive (milk, honey, eggs, silk, feathers, wool, &c.), or for what is afforded by their bodies after death (flesh, fat, horn, leather, fur, down, &c.), or for the service they render to man as co-operants in his labours (as beasts of burden, as guardians of other animals, as messengers, &c.). Some of the obvious problems concern the lost art of domestication, the actual origin of the existing domesticated animals, the persisting traces of wild ancestry, the improvement of breeds, and the possibility of adding to the list of the domesticated. (2) Not less important than the deliberate partnerships that man has established with domesticated and semi-domesticated animals, are those entirely natural inter-relations which contribute to the success of agricultural endeavour. Thus earthworms have made a great part of the fertile soil of the globe, and the visits of insects, in search of pollen and nectar, are indispensable to the cross-fertilization of the flowers of many plants important in agriculture. Many animals share in the great task of breaking down debris, burying dead bodies and organic refuse, making things clean, and, in general, keeping up the circulation of matter. (3) In the third place, there are many animals which are injurious to man's domesticated animals and cultivated plants, either directly or by affecting inter-related wild animals and wild plants. Thus we have to deal with beasts and birds of prey, with voracious vegetarians such as rabbits and voles, with snakes, with insects that sting animals or devour plants, with fruit-eating, bud eating, and grain-eating birds, and the difficult problem is how to control the balance of life. The first step is to have a secure and broad basis of facts as to the part which the animals in question play in the economy of nature. there can be no doubt, for instance, that many birds and mammals are destroyed without sufficient justification. It has to be borne in mind that an interference with the natural balance of life does not end with its immediate results, but has always secondary and much more distant consequence. Nor is it possible in many cases to give a clear verdict for or against any bird or mammal from the agriculturist's point of view, since there is often a combination of benefits and injuries. (4) It seems useful to make a separate division for those animals which are parasitic in man's stock of domesticated animals or in his vegetable plantations, some ectoparasitic, others endoparasitic,

and many of them very deadly. Here also fall to be considered the carriers of parasites from host to host, like the tse-tse flies which carry Trypanosomes, and, what comes to the same thing, the intermediate hosts of many less virulent parasites, like the minute water-snails which harbour the young stages of liver-flukes. Besides parasitic insects, mites, and worms, there are numerous parasitic Protozoa which modern research has shown to be almost as important as Bacteria. (5) A fifth group may include those animals that attack the work of the agriculturist,—from his dam to his fence, or the results of that work in the form of stores. White ants, boring larvæ, weevils, mites, and rats are familiar illustrations. (6) A group of beneficial animals may be recognized which destroy or check the injurious creatures mentioned in groups 3 and 5, thus stoats and owls check voles, ichneumon flies keep down caterpillars, and squirrels devour young wood-pigeons.

The study of the inter-relations between animals and agriculture is thus many-sided,—it raises problems of domestication, of breeding, of the balance of nature, of parasitism, of immunization, and so on.—Two general ideas stand out clearly amid an ever-increasing mass of detail. The one idea will always be associated with the work of Darwin, the idea of the web of life, of the inter relations of things, of the correlation of organisms. Nothing is unimportant, nothing lives or dies to itself. The other idea may be associated with the work of Pasteur, the idea of the control of life, that it is man's task, as it has been already in part his achievement, to meet thrust by counter-thrust, to conquer disease, to eliminate where necessary, to save where profitable, to bend Nature to his will, and even to create. [J. A. T.]

APPENDIX

Agricultural Holdings Acts (Scotland).—Since the publication of the article on this subject (vol i, p. 64, *et seq*) the Agricultural Holdings (Scotland) Act, 1908, has become law. This Act consolidated the enactments relating to agricultural holdings in Scotland, and repealed the Agricultural Holdings Acts of 1883, 1900, and 1906 (the latter of which never came into force), and also the Market Gardeners' Compensation (Scotland) Act, 1905. As, however, the 1908 Act did not to any extent introduce new legislation, but merely consolidated the provisions of the former Acts, the article already published is in the main a correct statement of the law as it now stands, except in so far as the references in that article to Acts now repealed are concerned.

It is to be noted, however, that although the 1908 Act repeals the former Acts, they may still require to be referred to under certain circumstances, *e.g.* compensation for improvements executed before the passing of the 1908 Act. As already pointed out, a tenant who has remained in his holding during two or more tenancies is not, on quitting his holding, deprived of his right to claim compensation under the Act by reason only that the improvements were not made during the tenancy on the determination of which he quits his holding. The compensation to be paid for improvements executed prior to 1st January, 1909, is such—if any—as could have been claimed if the 1908 Act had not been passed, and this involves a consideration of the Acts of 1883, 1900, and 1906. A tenant may claim for improvements under the 1883 Act, Part III of the Schedule, if executed subsequent to 1st January, 1874, and in the case of the improvements in Parts I and II of the Schedule to the 1883 Act, if the landlord has before 1st January, 1885, approved in writing of these improvements, though they were executed between 1st January, 1874, and the commencement of the Act.

With regard to improvements executed between 1st January, 1874, and 1st January, 1884, the tenant is, however, only entitled to compensation (1) if he was not under any express obligation to make the improvement, and (2) if he was not either by contract or custom entitled to compensation therefor.

With regard to improvements executed between 1st January, 1901, and 1st January, 1909, there are only two points to be noted —

(1) In the 1900 Act it was provided that, in estimating the value of an improvement, there should not be taken into account, as part of the improvement, what is justly due to the inherent capabilities of the soil. This proviso has been dropped in the 1908 Act, but the position of the tenant does not seem to be in any way altered by the omission, for it has never been suggested that a tenant could, on this ground, claim for an improvement against his landlord; and it simply comes to this, that a proviso which was of no practical utility has been discarded.

(2) Repairs to buildings, prior to the 1908 Act, required the previous written consent of the landlord, but now such repairs can be executed by the tenant, as already explained, without the landlord's consent. The section is not, however, retrospective, and consequently if such repairs have been executed prior to 1st January, 1909, without the landlord's consent, compensation cannot be claimed therefor.

Drainage.—With reference to drainage operations, it may be added to the statement of law previously given that the landlord cannot make an offer to do the work after the expiry of the notice if the tenant has commenced operations. If, however, the tenant has done nothing, the landlord will probably be entitled to undertake the work himself even after the expiry of the two months unless the tenant has withdrawn the notice, which, as already mentioned, he may do at any time before the landlord begins operations. The tenant, if he is to execute the work, must begin his operations within three months from the date of his notice; but if the landlord undertakes to do the work and then fails to commence operations within a reasonable time, the tenant may then go on with the work even although the three months have expired.

In a recent case, the tenants of a farm claimed to retain a portion of the rent on the ground that after entry to the farm they discovered the drains were badly laid and in a defective condition, in consequence whereof a 70-ac. field was flooded so that it was impossible to crop it; and that although the landlord had been called upon to remedy the defects he had failed to do so, and the tenants were thus deprived of the use of part of the subjects let. The Court decided that

the tenants, apart from express agreement, had no claim at common law against the landlord to have the drains put into working order, and that the tenants' only rights were those conferred upon them by the Agricultural Holdings Acts as explained.

Subsection 27 of Part III of the First Schedule to the 1908 Act now comprises repairs to buildings (referred to in vol. i, p. 66); and improvements in the case of market gardeners, which formerly were comprised in subsection 27 of Part III of the First Schedule to the 1900 Act, now appear in the Third Schedule to the 1908 Act.

Feedingstuffs in Farmyard Manure.—It was held in the Barcheskie case that where there was a clause in the lease to the following effect—'from the amount to be paid in compensation for the unexhausted manurial value of feedingstuffs the arbiters shall deduct any sum which, in their opinion, has been or shall be paid to the tenant on account of any increased award, by reason of the manurial value of the feedingstuffs consumed, put upon the dung left by the tenant'—the tenant was entitled to compensation in respect of the consumption on the holding of feedingstuffs the manurial residuum whereof entered the farmyard manure which was left unapplied to the land by the tenant at his outgoing and was taken over by the incoming tenant at valuation, but subject to deduction of such a sum, if any, as in the opinion of the arbiters may have been paid to the tenant on account of any increased award in the reference relating to the taking over of the manure in terms of the clause above quoted; that is to say, the landlord pays for the whole to begin with, but gets a reduction in so far as a payment is made by the incoming to the outgoing tenant for the dung left in the courts. It was also held that by 'value of feedingstuffs' was meant the original manurial value, *i.e.* the value of the manurial constituents of the feedingstuffs before the feedingstuffs were consumed.

Reduction of Claim for Manures, &c.—In the Tradunnock case the point was raised whether a tenant is entitled to claim for the unexhausted value of purchased artificial manures applied in conformity with the provisions of his lease. The lease contained a clause binding the tenant to apply a specified quantity of good farmyard dung per imperial acre, and so far as he had not the dung, a specified quantity of bone dust, guano, or other similar manure of equal value. The tenant applied sufficient quantities of artificial manure to meet the requirements of the lease, and on the expiry of his tenancy he claimed, *inter alia*, to be compensated for the unexhausted value of the artificial manures so applied. In answer to his claim the landlord contended that he was not entitled to claim for the unexhausted value of these manures except in so far as they might exceed the quantity stipulated for by the lease, and contended further that a benefit had been given or allowed to the tenant in consideration of his agreeing to this clause in the lease, inasmuch as otherwise a higher rent would have been demanded, and that this benefit must be taken into account in terms of the Agricultural Holdings Act in ascertaining the amount of compensation. The Court held that the landlord's position was untenable, and decided (1) that if a tenant has made an improvement in the sense of the Act, he is entitled to compensation therefor; and (2) that any benefit to be taken into account in ascertaining the amount thereof must be a benefit specially mentioned and allowed, that it was not possible to ascribe the execution of the particular improvements to the general benefit which the tenant might be supposed to take from paying a certain rent, and that consequently the tenant was entitled to claim for the unexhausted value of all purchased artificial manures applied to the land.

Compensation for Damage by Game.—In a recent case decided by Sheriff Johnston at Perth, the point arose as to the effect to be given to a clause in a lease dated prior to the commencement of the Act, which provided that the tenant should have no claim for damage done by game in any one year unless such damage exceeded £20. It was decided (1) that the agreement was not binding as an agreement, but (2) that it fell to be taken into consideration by the arbiter in fixing the compensation, and (3) that the arbiter was not bound to allow the full deduction of £20, but must allow such deduction, if any, as he deemed just, having regard to the fact that the agreement was voluntarily entered into by the parties.

Compensation for Unreasonable Disturbance.—In the Barcheskie case a claim was made for compensation for disturbance, and although the Court refused to answer the questions put by the arbiter, the Lord President made, *inter alia*, the following remarks on the subject of the grounds which will entitle a tenant to make a claim: 'Expressed in common language, what the clause was meant to do was, not to give fixity of tenure (which would have been a perfectly different thing), but to give compensation for what may be characterized as capricious disturbance on the part of the landlord, in capriciously putting an end to the lease. What reasons are capricious and what are not, no man would try to define. But of this I am sure, there may be perfectly good reasons for getting rid of a tenant which are not in the strict sense of the word agricultural reasons, and a landlord who gets rid of a tenant for one of these reasons, being a good one, is not liable under this clause. An agricultural reason would, of course, be that the tenant was a bad farmer. But there are many other classes of reasons. For instance, there is the reason that the rent is too low, and the tenant won't give any more. That would be a perfectly good reason, and in the same way I think it would come under the words of the second clause because it could not be said to be a reason inconsistent with good estate management. Good estate management means getting as much as your property is worth. There may be many other reasons equally valid. Suppose, for instance, the tenant made his farm the headquarters of low and disgraceful company. I imagine that would be a good reason for getting rid of him. Or suppose he made it his custom

to take every opportunity of insulting and being disagreeable to his landlord's family. If I were an arbiter I would hold that to be a good and sufficient reason.'

NOTICE OF CLAIM.—In the Camregan case, which finally went to the House of Lords, there was an agreement substituting agreed-on compensation for the compensation under the Act, and in addition the making a provision that 'no claim for compensation under the said Acts or under these conditions shall be made by the tenant later than one month prior to the determination of the tenancy'. The tenant gave notice of claim nineteen days before the termination of his tenancy instead of one month as provided by the lease, and founding on the agreement in the lease the landlord pled that the claim was excluded. The Court of Session and an appeal to the House of Lords decided that such a provision was void under the Act, and that the tenant was entitled to lodge his claim at any time before the termination of the lease.

REMOVING FOR NON-PAYMENT OF RENT.—The provisions of the 1908 Act are as follows —

In any case in which the landlord's right of hypothec for the rent has ceased and determined —*i.e.* under all leases dated subsequent to 11th November, 1881—

(1) When six months' rent of the holding is due and unpaid, it shall be lawful for the landlord to raise an action of removing before the Sheriff against the tenant, concluding for his removal from the holding at the term of Whitsunday or Martinmas next ensuing after the action is brought, and, unless the arrears of rent then due are paid or caution is found to the satisfaction of the Sheriff for the same, and for one year's rent further, the Sheriff may decern the tenant to remove, and eject him at such term in the same manner as if the lease were determined, and the tenant had been legally warned to remove.

(2) A tenant so removed shall have the rights of an outgoing tenant to which he would have been entitled if his lease had naturally expired at such term of Whitsunday or Martinmas.

(3) Where the tenant is in arrear to the extent of two years' rent, he may be summarily removed.

ARBITRATION —By Section 11 of the 1908 Act, re-enacting a similar provision in the 1906 Act, it was provided that all questions which under the Act or under a lease of an agricultural holding are referred to arbitration shall, whether the matter to which the arbitration relates arose before or after the passing of the Act, be determined, notwithstanding any agreement under the lease or otherwise providing for a different method of arbitration, by a single arbiter in accordance with the provisions set out in the Second Schedule to the Act. In a case which was raised shortly after the Act came into force (Stewart *v.* Williamson), the pursuer craved the Court to ordain the defender to appoint an arbiter to act along with the arbiter to be named by the pursuer in determining the value of the sheep stock belonging to the pursuer to be taken over by the defender at the expiry of the lease between the parties, with power to the arbiters to name an oversman as was provided by the lease. The defender refused to do this, and founded on the section of the Act above recited, the pursuer, on the other hand, contending that that section applied only to a reference of a judicial kind to a person to act in a judicial way in determining a dispute, and not to a mere reference for a valuation such as had arisen in this case. The Court of Session, and on appeal the House of Lords, decided that the section did apply, holding that it was of no consequence whether the parties were in controversy as to the liability to pay or as to the amount to be paid, and that accordingly the question in dispute fell to be decided by a reference to a single arbiter, and not by a reference to two arbiters and an oversman as provided by the lease In view of this decision the Agricultural Holdings (Scotland) Amendment Act, 1910, was passed, whereby the 1908 Act was amended to the effect that notwithstanding the provisions of section 11, as above explained, that section should not apply to valuations of sheep stocks, dung, fallow, straw, crops, fences, and other specific things the property of an outgoing tenant, agreed under a lease to be taken over from him at the determination of a tenancy by the proprietor or incoming tenant, or to any questions which it might be necessary to determine in order to ascertain the sum to be paid in pursuance of such agreement; and that whether such valuations and questions were referred to arbitration under the lease or not. [D. B.]

Agriculture, Development of. — By the Development and Road Improvement Funds Act, 1909, it is provided that the Treasury may, on the recommendation of the Development Commissioners appointed by the Act, make advances to a Government department, or through such department to a public authority, university, college, school or institution, or an association of persons or company not trading for profit, either by way of grant or loan, and on such conditions as they think fit, for any of the following purposes —

(*a*) Aiding and developing agriculture and rural industries by promoting scientific research, instruction and experiments in the science, methods, and practice of agriculture (including the provision of farm institutes), the organization of co-operation, instruction in marketing produce, and the extension of the provision of small holdings, and by the adoption of any other means which appear calculated to develop agriculture and rural industries;

(*b*) Forestry (including (1) the conducting of inquiries, experiments, and research for the purpose of promoting forestry and the teaching of methods of afforestation; (2) the purchase and planting of land found after inquiry to be suitable for afforestation);

(*c*) The reclamation and drainage of land;

(*d*) The general improvement of rural transport (including the making of light railways, but not including the construction or improvement of roads);

(*e*) The construction and improvement of harbours;

(*f*) The construction and improvement of inland navigations;

(*g*) The development and improvement of fisheries;

and for any other purpose calculated to promote the economic development of the United Kingdom.

A Development Fund is established into which shall be paid—

(*a*) such moneys as may from time to time be provided by Parliament for this purpose;

(*b*) sums provided from the Consolidated Fund; and

(*c*) sums received by the Treasury by way of interest on, or repayment of, loans made under the Act, and any profits or proceeds derived from the expenditure of any advance which by the terms on which it was made are to be paid to the Treasury.

For the year ending 31st March, 1911, and for each of the next succeeding four years, a sum of £500,000 is to be paid into the fund from the Consolidated Fund.

The Development Commissioners are appointed by the Crown, and their number was originally fixed at five, but has now been increased to eight in terms of an Amendment Act (10 Ed VII, c. 7). Subject to the provisions for retiral, the term of office is ten years After the first two years, one Commissioner shall retire every year but shall be eligible for reappointment, the order of retiral of those first appointed being fixed by the Crown. Provision is made for payment to not more than two of the Commissioners of such salaries, not exceeding in the aggregate £3000 per annum, as the Treasury may direct. The Commissioners may, with consent of the Treasury, appoint officials and determine their remuneration.

The Commissioners may appoint advisory committees, and may submit to any such committee for their advice any application referred to them Where an advance is made for any purpose which involves the acquisition of land, the body to whom the advance is made may acquire and hold land for the purpose; and if they are unable to acquire it on reasonable terms, the Commissioners may empower them to acquire the land compulsorily, provided such land does not form part of any park, garden, or pleasure ground, or does not form part of the home farm attached to and usually occupied with a mansion house, or is not otherwise required for the amenity or convenience of any dwelling house, or is not the property of any local authority, or has not been acquired by any corporation or company for the purposes of a railway, dock, canal, water or other public undertaking, or is not the site of an ancient monument or other object of archæological interest. The Commissioners, in making an Order for the compulsory purchase of land, shall have regard to the extent of land held or occupied in the locality by any owner or tenant and to the convenience of other property, belonging to or occupied by the same owner or tenant, and shall, so far as practicable, avoid taking an undue or inconvenient quantity of land from any one owner or tenant; and for that purpose, where part only of a holding is taken, shall take into consideration the size and character of the existing agricultural buildings not proposed to be taken, which are used in connection with the holding, and the quantity and nature of the land available for occupation therewith, and shall also so far as practicable avoid displacing any considerable number of agricultural labourers or others employed on or about the land.

Where land is to be acquired compulsorily, the draft order shall be published in the manner prescribed by the Commissioners, and notice shall be given, both in the locality in which the land is proposed to be acquired, and to the owners, lessees, and occupiers, and, in the case of land forming part of a common, open space, or allotment, also to the Board of Agriculture and Fisheries. The compensation payable for such compulsory purchase is to be determined by a single arbitrator, to be appointed, in England by the Lord Chief Justice, in Scotland by the Lord President of the Court of Session, and in Ireland by the Lord Chief Justice. No additional allowance is to be made on account of the purchase being compulsory, and the arbitrator must take into account the extent to which the remaining and contiguous lands belonging to the same proprietor may be benefited by the proposed work for which the land is to be acquired. Where buildings are to be acquired, the Order may provide that part only of the buildings are to be taken if the arbitrator is of opinion that this can be done without material detriment to the remainder, compensation being paid for any damage sustained by severance or otherwise.

The expression 'agricultural and rural industries' includes agriculture, horticulture, dairying, the breeding of horses, cattle, and other live stock and poultry, the cultivation of bees, home and cottage industries, the cultivation and preparation of flax, the cultivation and manufacture of tobacco, and any industries immediately connected with and subservient to any of the said matters.

In approving, executing, or making advances in respect of the execution of any work under the Act involving the employment of labour on a considerable scale, regard shall be had, so far as is reasonably practicable, to the general state and prospects of employment. An Order made by the Commissioners for the acquisition of land forming part of a common, open space, or allotment shall be provisional only, and shall not have effect until confirmed by Parliament, except where the Order provides for giving in exchange for such land other land, not being less in area, certified by the Board of Agriculture and Fisheries to be equally advantageous to the persons entitled to commonable or other rights, and to the public. Before giving such certificate of equality of exchange, notice of the proposed exchange must be given, and all parties interested afforded an opportunity of objecting thereto. This provision, however, does not apply to the acquisition of common land for the purpose of forestry, provided the public have reasonable access to the land for exercise and recreation, unless the land has been dedicated to public use or is a metropolitan common or a suburban common, or is subject to a scheme of regulation made in pursuance of the Metropolitan Commons Acts or the Inclosure Acts, or to a private

or local Act of Parliament. The expression 'common' includes any land subject to be enclosed under the Inclosure Acts, and any town or village green; the expression 'open space' means any land laid out as a public garden or used for the purpose of public recreation, and any disused burial ground; and the expression 'allotment' means any allotment set out as a fuel allotment or a field garden allotment under an Inclosure Act. See also under ROAD in this volume. [D. B.]

Animals, Cruelty to.—The Wild Animals in Captivity Protection Act (vol 1, p. 148) has now been extended to Scotland by the provisions of 9 Ed. VII, c. 33. See also below—DISEASES OF ANIMALS ACTS. [D B.]

Beet, Sugar.—During the publication of this work the sugar-beet movement has continued to attract attention. Four-fifths of the sugar consumed in Great Britain is beet sugar (which no one can tell from cane sugar when refined), and all of it is manufactured from beet grown on the Continent. Some of it, it is true, is refined in this country, but this is only a small proportion. The situation is the more striking in that we consume more sugar per head than any other nation.

A beet-sugar factory was established by James Duncan, a famous London refiner, at Lavenham, Suffolk, in 1870, and worked under his control and the control of his successors for some years. The factory was only a half factory, however; that is to say, the manufacturing process stopped at the production of the juice. This juice was sent to London, and mixed with the syrup of imported raw sugar, so no one has yet seen a lump of English beet sugar. An attempt was made in 1909 to start a factory at Sleaford, Lincs. The capital was £130,000, but after £64,000 had been subscribed, the scheme fell through. Contracts had been made with 264 farmers for 1980 ac. of beet. In 1910 a Dutch firm of sugar manufacturers started, in conjunction with English directors, the East Anglia Sugar Company to erect a factory and refinery at Maldon, Essex, and about 200 ac. of beets were grown under its auspices as an experimental crop. A certain quantity was also grown in Norfolk and Lincolnshire for Dutch buyers. In various parts of the country schemes for factories have also been launched, but the capital for no single company has yet been raised.

THE EAST ANGLIAN CROPS.—Owing to bad weather and lack of knowledge and experience the crops were of a disappointing character, a great deal of money was lost, and two of the English directors retired from the board. Details of the crops grown for the Hollandia and Arnhem companies have been published. One was 7·9 tons and the other 9½ tons. The former is washed weight and the latter railway weight. These figures are, it will be seen, far below what had been anticipated. It was only late in the day that it was realized that the factories pay only for the weight calculated from a sample of roots which have been (1) scrubbed and cleaned as parsnips are scrubbed for the table; (2) deprived of their tops, that is, all the part of the beets which is above the ground level, and therefore containing impure sugar; and (3) side roots. The weight of dirt marketed with the Essex beets was returned in some cases at more than 60 per cent! This is because, in calculating the deduction for dirt, the factories double the amount when it exceeds 20 per cent.

Another point which had not been brought out in beet-sugar advocacy was that the average Continental yield per acre, after years of experience, is much below the figures which growers are encouraged to expect in this country. Taking the ten years period, 1899 to 1908, only one country, Belgium, produces more than 12 tons; Germany and France and Denmark are the only countries which get beyond 11 tons, while Holland produces only 10·6 tons—which is the 1901–8 average in the United States. No doubt these averages are brought down by starved culture and poor soil On the other hand, the foreign cultivator has the advantage of long and hereditary experience. Undoubtedly a large proportion of foreign crops is carefully and skilfully cultivated and liberally treated. Many of our farmers, with their well-known skill in root growing, will no doubt be able in time to secure crops equal to those grown in the best Continental practice in the best soils, but that will not be next year; and even these crops cannot be those of the kitchen-garden work on experimental plots which, in many districts, has given such an erroneous impression as to possible yields. No one doubts the possibility of growing a large quantity of any kind of roots in Great Britain, but though some large crops of beet, with a high sugar percentage, are recorded abroad, it is generally found that heavy yields, obtained by excessive manuring, mean roots deficient in sugar, and, as the factories pay not only by weight, but in relation to the sugar percentage, they are not profitable. Personal enquiry on the Continent shows that good farmers are content with quite moderate yields.

THE RETURN.—A wrong impression has also been given as to the return per acre. Several beet-sugar advocates have spoken of £5 or £6, or even more. Continental experience gives no ground for supposing that such results will be obtained. It is very doubtful whether many Continental growers make more than £1 per acre. There are undoubtedly large numbers who do not make even that. The main return is in the improved condition of the ground due to the deep cultivation for the deep-rooting beet, and to the continuous hoeing, to the bits of roots left in the ground, to the enormous weight of leaf and top, and to the pulp and saturation lime returned from the factory. The leaves and tops, even as late as September, may be heavier than the roots. The wet slices are returned to the farmer from the factory in some proportion to the roots he supplies, say 40 per cent. They contain a great deal of water, and many farmers prefer a very much smaller quantity of dried slices, the allowance of which might be, perhaps, 4 per cent. The wet slices are very much like macaroni as it is taken from the cook's pan; the dried slices are like dried seaweed, as it lies in summertime above high-water mark. The wet slices are clamped or siloed and used

with dry food. The dried slices are soaked in water for use. There are several kinds of dried slices. Some contain a very small proportion of sugar; others have had cheap cane sugar added to them; a third kind has been allowed to retain a large proportion of its own sugar. But it is not easy to see how, in Great Britain, when the beets have been got to the factory, it would be profitable not to take the largest possible quantity of sugar out of them. Dried slices at a fair price may be not only a convenient, but a useful food for stock. But the time has hardly arrived for trustworthy quotations for factory by-products. The value of these by-products, like the value of the beet crop itself, has also to be considered in relation to our existing root crops. Beet occupies a place in Continental rotations which is not vacant here. On the other hand, it is to be borne in mind that our farmers grow their turnips at a loss and are not always able to show a profit on their mangels, while beet is a crop paid for in cash within a few days of delivery, on a five years' contract, and not put through stock before it is turned into money No doubt many other crops would profit greatly if they had the thorough cultivation which beets receive, but sugar-beet advocates are entitled to ask whether beet crops would not hasten that improved cultivation

Mr. Cohen, on behalf of a Dutch syndicate, has offered 18*s* 6*d*. per ton, for, for roots exported to Holland, and has promised 21*s* 6*d* per ton, delivered, when a factory is started These are higher prices than have been offered in connection with any factory scheme The cost of producing the crop has undoubtedly been understated, and cannot be expected to be less than £10 per acre. In Germany on very many farms it is undoubtedly more than that. It has been placed as high as £14 more than once. The experimental crops which have been grown by the Board of Agriculture and by Mr Cohen's syndicate will no doubt throw light on the actual cost of production in commercial conditions. While it cannot all be thrown upon the beet crop, the cultivation of which is of such great advantage to following crops, it must obviously bear some relation to the cost of producing mangels and to the return per acre.

Labour.—More labour is undoubtedly wanted in cultivating beet than in cultivating mangel. While a number of ingenious horse-hoeing and singling machines are in use on the Continent, and can be imported or adapted here for our use, singling must be finished by hand, and a great deal of careful hand hoeing must be done. The labour difficulty and the cottage difficulty form together an anxious problem for many farmers contemplating beet-growing. It is urged that the factories would increase the supply of labour in rural districts. At first, however, they might have the effect of diminishing it. The proposal to organize labour gangs for hoeing as in the arrangements made for hop-picking may or may not be practical. The harvesting problem may be met by the use of horse or steam machines, the pairs of feet of which are drawn through the ground on either side of the roots and have thus the effect of loosening the beets so that they can be easily lifted out by hand and piled as required. The art of slicing the tops off the beets quickly and without waste needs learning. The beet crop in Germany and Denmark is hoed and harvested largely by the aid of Polish and Galician women imported by national organizations. It is doubtful if adult labour in connection with the beet crop on the Continent is much below the price which would have to be paid here, at any rate in the Eastern counties Much of it undoubtedly is not. At the same time a great deal of child labour is used. Child labour is particularly serviceable in the work of singling, for the little plants which are allowed to remain must be carefully handled if they are to do well. School holidays are arranged so that the children may work in the fields It is not at all certain, however, that much child labour will be available in this country, and the association of sugar-beet-growing with cheap labour does not make it more popular here.

Factories.—Some of the labour in the Continental factories is paid for at a modest rate, but there is also a large amount of technical assistance which we could not buy at the same price The question of ways and means, as far as the factories are concerned, is of vital importance to the farmer, for if the factories cannot pay, beet-growing cannot go on. The great drawback to beet-sugar factories is that they are collections of expensive machinery which is used only for about three months in the year Jam-making and kindred industries, which have been suggested as a means of keeping open the rest of the year, do not seem a very promising auxiliary way of making money, and one does not hear of them on the Continent In the Maldon scheme it was proposed to keep open all the year round by undertaking the refining of raw sugar.

It is obvious that a pioneer factory must be largely controlled by foreigners, for we have no practical acquaintance with a beet-sugar industry. The East Anglia company was promising in that it seemed to offer a combination of Continental and English experience. An English board would be wholly in the hands of experts who might, or might not, be well chosen. The heads of departments in Continental factories are highly trained, because not only factories, but sugar schools and sugar journals, abound there.

There are other problems in connection with the factories than sugar manufacture. There is the disposal of waste water, which, owing to the proteid in it, may be highly offensive. Even the disposal of the soil is no light matter. Clearly the soil attached to 50,000 tons of roots (which a factory might handle in a season) is a considerable quantity. Many Continental farmers are required to take back their proportion of soil.

A great advantage enjoyed by the Continental grower is his nearness to the factories. He has sometimes a choice. He is usually so near that he can send his beets in his wagons, and have them come back laden with pulp. At the start in this country a large proportion of a factory's

beets would have to be brought from a distance by rail.

THE PUBLIC ASPECT.—Owing to the different development which our agriculture has taken, and the place which roots already occupy in our rotations, it is difficult to see how there could be beet-growing on anything like the Continental scale. Again, the standard of cultivation here is higher than in many parts of the United States where the introduction of the beet crop has undoubtedly done great service. On the other hand, there is a good deal to be said for the crop not only agriculturally but economically. It might not be such a bad thing if we produced some of our own sugar. And it is not only the good effect of beet cultivation on areas which are by no means so thoroughly cultivated as they might be which has to be taken into account. The presence of beet-sugar factories, with their active inspectors disseminating a knowledge of agricultural chemistry, botany, and bacteriology, might be expected to have a high educational value. It might also have the effect of promoting among agriculturists a greater recognition of the value of well-thought-out methods of co-operation.

The ideal sugar factory would be of course a co-operative one. Many of the Continental factories are practically owned by the farmers who supply the beets to them. Under this arrangement the farmer can afford to accept a low return for his beets, because he also gets a profit as a sugar manufacturer. It is said that half the beets grown in Germany are grown on farms belonging to the factories. A word may here be said on the dividends of German factories which have figured in some sugar-beet propaganda. The high figures give an erroneous impression of the amount of profit made, for a large amount of capital has been repaid. It is well known that co-operative societies in this country are able to trade on a very small capital. The dividends paid in America are due in part to the fact that they are earned behind a tariff wall which enables the manufacturer to benefit to the extent of 7*s* per cwt. But the fact that in 1910 the factories of free trading Holland overbid the factories of Protectionist Germany for 150,000 tons of German beets suggests that the question of factories is hardly a simple one to be solved by tariff wall proposals.

Since the Brussels Convention the signatory powers have been unable to impose an import duty in excess of half a crown a cwt. Great Britain has a duty of 1*s*. 10*d*. It is suggested that that duty might be retained, without any excise duty being imposed. Reluctance to adopt this course is expressed because both political parties have advocated cheap sugar and there is a desire to abolish the import duty altogether; also it is not easy to see the limit to this "protective" period for the factories' benefit. Further, it is held to be inexpedient in connection with an industry the degree of usefulness of which, in the existing state of our agriculture, is in some doubt, to take any step which may lead to other than a perfectly natural and commercial start. Sugar made in England would find a market in the neighbourhood of the factory, and would thus save freight across the North Sea and shipping and landing charges. It is argued that if, with this advantage at its back, a beet-sugar industry cannot face Continental competition, the margin of profit is not sufficient to justify introducing it. Under the Brussels Convention the Government is of course forbidden to stimulate a sugar industry by grants to commercial companies.

THE OUTLOOK.—Those who have for so many years kept the sugar-beet question under public notice are entitled to credit, and the feeling of those who have studied the subject and have thought about rural problems is that it is desirable that the experiment of a factory should be tried. There are a great many things of which no certain knowledge can be had until the first factory is actually at work. At the same time, it is to be regretted that so much sugar advocacy has been characterized by over-statement and by an imperfect presentation of some considerations which must be taken into account in deciding on the real value of sugar-beet-growing and beet-sugar manufacture in this country.

It is to be remembered that because we consume enormous quantities of some particular product, that is by no means to say that it is expedient, on the whole, that we should forthwith set about its manufacture. The value of the sugar imported into this country reaches a high sum. But the value of the butter we receive from abroad is even higher. Why do we prefer to get other people to make that butter instead of making it ourselves? Because we can, we think, employ our energies and capital to better advantage. The same is true as to a large proportion of the eggs we import, and not a little of the meat. The sugar-beet question is, in fact, an extremely complicated one. It needs to be looked at all round, and this involves not only a close acquaintance with the details of beet-growing and sugar manufacture abroad, and agricultural and social conditions on the Continent, but a sound knowledge of the agricultural and economic situation in our own country. Not all those who have spoken and written so freely on the subject have been thus equipped. The wise conclusion seems to be that Continental syndicates which desire to promote beet-growing over here and start factories should receive encouragement from landowners and agriculturists, provided they set to work in promising districts and on businesslike lines, but that it is undesirable that the State should give a national imprimatur to beet-sugar manufacture until those advocating it have demonstrated by actual experiment what its prospects really are in this country.

The interest taken by Dutch capitalists in beet-growing in this country is due to the fact that the areas under beet in Germany, France, and Holland are now filled up. Last year Dutch manufacturers were buying beet in Germany as well as in England. In some parts of the Continent and the United States, however, the beet area has been invaded by other crops, and it is important to recognize the possibility of

this, for beet is merely the raw material of the marketable product. With regard to the world's consumption of sugar there can be no doubt that it is steadily increasing. Every year, however, cane-sugar production seems to be on a sounder basis, and, while there are obvious drawbacks to tropical manufactures, there will always be some economical considerations favouring the production of sugar where those concerned in the industry do not need so large a proportion of the product in order to keep themselves warm! Why does not beet-sugar production advance more rapidly in the United States? If beet-growing has reached its maximum in western Europe there is a great prospect of its extension in Russia, and possibly in Northern Asia.

It is unnecessary to add instructions for cultivation, as in every district where it is proposed to establish a factory, the best Continental experience will be placed at the disposal of the farmers.

STATISTICS.—Appended are the latest statistics: Average consumption of sugar per head in the United Kingdom in 1910, 86 lb. World's sugar production in 1910–11 cane, 8,274,000 tons; beet, 8,579,711 tons. In 1909 our Colonies were unable to supply more than 85,000 tons towards the 1,760,157 tons of sugar we needed. At a well-known German factory in 1909, 6 tons of roots produced a ton of sugar. The roots cost the factory 21·136*s* per ton, and the total expenses of manufacture brought up the cost per ton of roots to 28·39*s*. The cost per ton of sugar was 8*s*. 6*d*. per cwt. The sugar fetched 10*s*. 6*d*. A raw-sugar factory consumes 6 per cent of coal and 5 per cent of limestone per beet weight (Koppeschaar), and needs each day an enormous volume of water. There are astonishing fluctuations in the price of sugar: in August, 1910, the price of raw sugar was 14*s*., but by October of the same year 9*s*.

(Sugar Beet: Some Facts and Some Illusions, A Study in Rural Therapeutics. London, 1911.)

['11 c.]

Diseases of Animals Acts.—Provision has been made by 9 Ed. VII, c. 25, for the payment by the Local Authority of fees to veterinary surgeons and practitioners for notification of diseases of animals.

The Diseases of Animals Acts have further been amended by 10 Ed. VII and 1 Geo. V, c. 20, in respect of the exportation and shipment of horses. The provisions of this Act are as follows. It is unlawful to ship or attempt to ship any horse from any port in Great Britain to any port outside the British Isles, unless immediately before shipment the horse has been examined by a veterinary inspector appointed by the Board of Agriculture and Fisheries for the purpose of conducting such examinations, and has been certified by him in writing to be capable of being conveyed to such port and disembarked without cruelty. If any horse shall be found by the veterinary inspector to be in such a physical condition that it is cruel to keep it alive, it shall be lawful for him, without the consent of the owner, to have the animal slaughtered in such a manner as to inflict as little suffering as practicable. The Board are entitled to charge for any licence, permit, or examination relating to the shipment of horses, such fee as may be prescribed by order of the Board. If any horse shipped abroad has a limb broken, or is otherwise seriously injured while on board, so as to be incapable of being disembarked without cruelty, the master of the vessel shall forthwith cause the animal to be slaughtered, for which purpose the vessel must carry a proper killing instrument. The inspectors of the Board have powers of entry on any vessel, for the purposes of seeing that the provisions of the Act are being complied with, and it is the duty of every Local Authority to enforce the Act. The provisions of the Act shall not apply in the case of the shipment of any thoroughbred horse certified in writing by a steward, or the Secretary of the Jockey Club—

(*a*) to have arrived in Great Britain not more than one month before the date of shipment for the purpose of being run in a race; or

(*b*) to be shipped for the purpose of being run in a race; or

(*c*) to be shipped in order to be used for breeding purposes;

provided such certificate be delivered at the time of shipment to the master of the vessel on which the animal is shipped, who shall, on demand, produce the certificate to any constable or officer of the Board or Local Authority, and allow such person to take a copy of, or extract from it.

[D B]

Dry Farming.—Dry farming is a new term coined to describe a system that has recently become prominent. It has been found that the methods of farming where the annual precipitation is limited must be quite different from those practised where the rainfall is greater. The commonly accepted idea of the term at the present time in Western America, where dry farming is much practised, includes any kind of farm operations carried on where the total annual precipitation is less than 20 in. The cardinal principle that underlies the methods adapted and makes the growing of crops profitable, where only this amount of rainfall is received, lies in bare summer-fallowing, or in giving careful summer-tillage once in two or once in three years; that is, preventing absolutely the growth of any vegetation on the land during the summer, thus allowing all moisture that comes to work down into the ground. The operations required to prevent vegetation from growing necessarily keep the surface of the ground loose and form a mulch which reduces evaporation to the minimum. The amount of moisture thus stored up by a thorough tillage during one season is sufficient to supplement the rainfall the following year, so that crops may be raised during a season when extremely little rain actually falls on them while growing. When the subsoil is of a close or clayish formation and retentive of moisture, the effect of this summer-tillage or summer-fallow lasts for more than one year. The second crop after summer-fallowing receives some of the benefit, consequently two years' rainfall is

used to produce one crop if the summer-fallowing is done every other year, or three years' rainfall is utilized to raise two crops if the summer-fallowing comes once in three years. This idea of giving a bare summer-fallow, or to express it in a term more often used, summer-tillage, with the sole purpose in view of storing up moisture to be used in the following season, is a principle which differentiates dry farming from the ordinary farm practices. There are a number of minor details, such as the use of the subsoil packer, the generous use of the harrow and possibly the disk harrow to maintain a surface mulch, the time of ploughing, &c, which are all important in their way; but the summer-fallow for the sole purpose of carrying moisture from one year over to the next is an idea essential to dry farming and is the basis of its success.

To realize the importance of a bare summer-fallow in storing up moisture where the rainfall is limited, one must understand that there is absolutely no ground water under ordinary circumstances that can affect the crop in any way. As a usual thing the ground is absolutely dry from 25 to 50 ft. down—often much deeper—and it is the exception rather than the rule where the moisture is reached at so shallow a depth as 12 or 14 ft. In the ordinary course of events the rainfall does not penetrate down into the soil more than from 2 to 3 ft. In the drier districts a period of rainy weather that will wet the prairie soil down to 1½ ft is considered quite heavy. If on the other hand the land has been ploughed and no crop is allowed to grow, this moisture is not used up but remains in the soil. The dry layer underneath prevents it from leaching downward, and here it can be held for an almost indefinite period, provided no plants are growing on it to draw on the moisture, and evaporation is prevented by forming a soil mulch at the surface. Under ordinary circumstances, after the prairie has been wetted down to 1½ ft., and no rains come for a few weeks, the growing vegetation absorbs practically all the moisture, and when another heavy rain does come it will probably not sink in to any greater depth than the previous one, but on a piece of land that has been summer-tilled this rain is readily absorbed and the moisture zone is lowered into the subsoil in proportion to the amount of the rainfall.

In September the writer has by the use of a soil auger found moisture to a depth of 6 or 7 ft. on prairie land that had been broken in May and early June, while on the virgin prairie a few feet away it was 'powdery dry' down as far as was gone with the soil auger.

Methods of Dry Farming in Western Canada - In the southern part of Alberta and Saskatchewan the principles of dry farming are recognized, and the following brief description gives the methods practised by the most successful farmers in handling the land for the raising of wheat.

Virgin Prairie.—It has been found that it is not profitable to sow crops on sod land the same spring that the land is broken, with the possible exception of flax. The most common practice is to break the sod during the rainy season, that is, during May and June. The sod should be rolled down immediately behind the plough. If a tractor is used it is important that a heavy roller be attached behind the ploughs. If the land is being broken with horses the ploughman should attach his team to a heavy roller at noon and at night, and go over the land just broken before leaving the field. The sods when they are freshly ploughed flatten down more easily. It is important that a close connection be made between the furrow slice and the subsoil, for if an air space is left, the sods are apt to dry out, and rapid rotting is thus prevented. In connection with the question as to the best depth to break, the two methods of handling the sod should be mentioned. The most common practice is to break from 3 to 4 in. deep, or just as deep as the plough will turn the furrow over perfectly flat, that is, upside down without lapping on the furrow turned by the previous round. After the land has been broken and rolled, a certain amount of surface cultivation is given during the summer, and the land is sown early the following spring with spring grain, or if in the winter wheat district, it is sown with winter wheat in the latter part of August or early in September of the same year it is broken. The implements used to give this surface cultivation during the summer are the ordinary harrow and disk harrow. In disking it is important that the disks are not set so as to cut through the sods. They should only turn the soil up for about half the thickness of the sod, and it is well to follow immediately with the harrow, the idea is merely to form a shallow mulch of loose soil on top of the sods, and also to fill in the cracks between the sods. If this disking and harrowing can be done after a rain, while the sods are still moist, it will be found that much more good is accomplished by the same amount of labour. The usual amount of work put on the sod to form a seedbed when handled in this way is, one double disking, a harrowing, another double disking, and either one or two harrowings more.

Another method is to break the land some time during May or June while there is considerable moisture in the soil, as shallow as possible, usually about 2 in. The sods are immediately rolled down, but the land is left without any further surface cultivation until the latter part of the summer, when it is ploughed at least 2 in deeper than it was broken. This method is called 'backsetting', and is the one recommended wherever a settler can get the time to do it. Land which is to be put into garden or trees has to be handled in this way to obtain satisfactory results. Immediately after the land has been backset it should be thoroughly harrowed, and if necessary double disked and harrowed. The land should not be allowed to go into the winter in a lumpy condition, for if it is, considerable moisture will be lost on account of the soil being too loose. The use of a heavy sub-surface packer just after the land has been ploughed this second time will usually give beneficial results.

The two important things to see to in the

preparation of sod land for the first crop, no matter whether the sod is broken once 3 or 4 in. deep, or broken shallow and backset later on in the season, are, first, to roll or flatten the sods down and so do away with any air spaces between the furrow slice and the subsoil which would have a tendency to prevent the sods from rotting; and second, the surface cultivation given should be shallow, just enough to form a surface mulch, which will tend to retain moisture in the sods and cause them to rot rapidly. Under normal conditions, by the middle or end of August the sods themselves should not only be well rotted, but the root fibre from 2 to 3 in down into the subsoil should be rotted also. In this way a large amount of plant food is made available for the crop besides storing up a goodly supply of moisture in the subsoil. Under these conditions the moisture zone will extend from 4 to 6 or 7 ft. down from the surface.

Season of Breaking – The season of the year that sod is broken is quite important Throughout Western Canada the usual breaking season is during the rainy season of May and June At this time the grass is growing and the roots are very succulent, and when the sod is turned over the rotting process begins at once. Quite often generous rains during the early part of the autumn are received, and, on account of the sod being in such excellent condition to plough, new settlers are often tempted to break some of their land A word of caution in this connection would not be out of place

Before the virgin prairie soil is in a condition to produce a maximum crop, the root fibre therein must have had a chance to rot To produce rotting, three things are required — heat, moisture, and air. If the sod is broken in the autumn, there is no chance for bacterial action to take place on account of the lack of heat, consequently, in the spring of the year the sods are in very much the same condition as they were at time of ploughing, and are in little, if any, better condition to grow a crop than if the sod had been freshly broken in the spring. There is absolutely no objection to breaking the sod in the fall provided it is not cropped the following spring, but treated the same as if broken in the spring during the 'breaking season'.

Growing Flax on Fresh Breaking. — In some localities flax, when sown on fresh breaking, gives quite profitable returns in seasons of normal rainfall. One of the principal objections is, however, that the growing crop takes so much moisture out of the sods that they do not have an opportunity of rotting, and the crop following flax is invariably light; and consequently a thorough summer-fallow should be given the land on which flax has been grown the first season. Another objection to the growing of flax is that it is very difficult to obtain seed that is free from noxious weed seeds, and a farmer is very apt to infest his new clean land with seeds that he will probably never get entirely rid of. The advantage, on the other hand, of a flax crop is that it gives quick cash returns. The usual preparation for flax is to break from 3 to 3½ in. deep, roll immediately, and give just enough surface cultivation to fill in the cracks between the sods. The flax should be sown as soon after breaking as it is possible to do so, and the surface of the land should be left very smooth otherwise the harvesting will be made difficult.

Summer-Fallowing. — As indicated above, summer-fallowing is a necessity under dry-farming methods. The following is a description of the usual method now followed by the most successful wheat growers. If diversified farming is to be attempted, which would certainly be very advisable, the method of procedure would have to be modified. However, on account of lack of space we shall confine ourselves to describing the method now generally in vogue, which is to summer-fallow the land, raise two crops of wheat, and then summer-fallow In preparing for summer-fallow the stubble should be double-disked as early in the spring as possible If time will permit, it is wise to begin this disking just as soon as the frost draws out sufficiently. Often it is practicable to have the disk going in the fields in the afternoons while frost would still prevent doing so in the forenoons The object is twofold. It will form a shallow mulch which will help to retain the winter moisture and will also cover many weed seeds and kernels of grain left on the ground from the previous harvest. As soon as vegetation starts and the weeds have all germinated, the land should be ploughed a fairly good depth, and harrowed immediately after ploughing In the course of a week or ten days, if there are any weed seeds germinated a second harrowing will kill a great many of them. During the summer, if a crust forms after a heavy rain a harrowing should be given to break it up. During the season, if there are any weeds that the harrows will not destroy a duck-foot cultivator should be used on the land. Absolutely no weeds should be allowed to grow. By ploughing the land as early as this in the season, no moisture is used by growing plants A great mistake is made by many farmers by putting off this ploughing until the weeds are a few inches to a foot or more in height. This unnecessary vegetation pumps a tremendous amount of moisture out of the land; and when it is ploughed, instead of turning over in a moist mellow condition, it is almost certain to be lumpy and quite dry. On land that has been properly summer-fallowed it is possible to sow winter wheat at any time during the latter part of the summer or early in autumn and have enough moisture to bring it right up Usually the mulch is not more than 2 or 3 in. deep; but no matter what depth the mulch is, the winter wheat should be put in deep enough to reach moisture.

After the land has been thoroughly summer-fallowed, two crops are generally taken off without further ploughing. It is usually wise to cut the grain high so as to leave as much stubble as possible on the ground to catch the snow. Fall ploughing is not usually recommended, for on account of the high winds that often prevail during the winter the snow is blown off the ploughed ground, while the unploughed

stubble will hold it to a great extent. Another objection to fall ploughing is that the stubble turned under has a tendency to keep the land too loose and open, thus causing it to dry out considerably.

After the crop following the summer-fallow has been cut, some farmers follow the practice of disking the land, but the usual practice is to let the stubble land remain untouched until the spring and then double-disk, if the stubble is not too thick to prevent so doing, and then seed immediately without ploughing; if the land is badly infested with weeds the stubble is burned off. If this is done it is important that the surface of the ground be stirred immediately after the burning, otherwise it will dry out extremely fast For this purpose a spring tooth cultivator with narrow teeth makes a particularly satisfactory implement. The land is then sown with spring wheat For oats it is considered a better practice to plough before sowing. The ploughing at this time should be shallow. In this connection it might be well to speak of the importance of harrowing immediately after the plough. If a sulky or gang-plough is used, it is well to attach a section of the harrow behind the plough If an engine is used, a harrow just wide enough to cover the furrows ploughed should be used On land that is being ploughed to be put into crop immediately, and also in the case of fall ploughing, a packer should be used Some form of a subsurface packer will probably give the best results The packer should be immediately followed with a harrow so that a surface mulch may be maintained The object of the packing is to prevent air spaces as much as possible in the soil and to connect the furrow slice with the subsoil

The Aim of Dry Farming Methods.—To summarize very briefly the objects aimed at in all dry farming methods, the following points might be mentioned: ploughing the land so that it will be in a condition to receive and absorb all the moisture that falls; cultivating the surface of the land to maintain as much as possible a surface mulch that will prevent evaporation, preventing all vegetation, except the crop planted, from growing on the land no matter what time during the year, so as to prevent the loss of moisture in the maintenance of unprofitable vegetation

Where the rainfall is less than 20 in. it is not usually possible to raise crops every year, therefore it is necessary to keep the land absolutely free from any vegetable growth for a whole season to store up moisture for the one or two crops that are to follow.

The kind of implements used is of minor importance providing it is possible to carry out the above-mentioned conditions.

The detailed methods described above apply more particularly to conditions as found in Southern Alberta and Southern or South-western Saskatchewan. It might be well to point out that in the Western States on the Pacific slope, where the precipitation is greater in the winter time, some of the details, such as best time to plough, &c., will be materially modified.

[W. H. F.]

Duties on Land Values.—The Finance (1909-10) Act of 1910 imposed certain taxes on land values, and as the subjects taxed have not, apart from death duties, been hitherto taxed, and the principles of valuation are new, a few words of explanation may be of interest.

Valuation.—For the purposes of the Act the Commissioners of Inland Revenue must, as soon as may be after the passing of the Act, cause a provisional valuation of all the land in the United Kingdom to be made, to which end every owner of, and every person receiving rent in respect of, land must on requisition furnish to the Commissioners a Return, containing such particulars as may properly be required by them for the valuation of the land, within thirty days after notice, under a penalty of £50 on default This valuation is to be made up as at 30th April, 1909, and is to show separately the total value and also the site value, and, in the case of agricultural land, its value for agricultural purposes, where that value is different from the site value In order to ascertain these values, the gross value of the land has first to be fixed, and this is defined as 'the amount which the fee simple of the land, if sold at the time, in the open market, by a willing seller, in its then condition free from incumbrances and from any burden, charge, or restriction (other than rates or taxes), might be expected to realise'. The total value is the gross value, subject to the amount by which it would be diminished by deducting any fixed charges or any other burdens affecting the land.

The full site value means the amount which remains after deducting from the gross value the difference (if any) between that value and the value of the land, if sold in open market by a willing seller, divested of buildings and of everything growing on it The assessable site value means the total value after deducting: the same amount as in the case of full site value; any part of the total value attributable to capital expenditure for the purpose of improving the land for purposes of building or any industry other than agriculture, any part of the total value attributable to streets, gardens, or open spaces for the use of the public; any part of the total value attributable to the redemption of fixed charges, or effecting the release of agreements restricting the use of the land, or to goodwill, &c.; any sums necessary to clear the land of buildings, trees, &c., which have to be taken into account in arriving at the full site value.

When this provisional valuation has been made, a copy thereof is to be served on the owner of the land, who has the right of appeal if he give notice of objection within sixty days of the service of the notice. If no notice of objection is given the valuation becomes final. This valuation when fixed becomes the basis for settling the duties imposed by the Act, which are four in number, viz.: the increment value duty; the reversion duty; the undeveloped land duty, and the mineral rights duty.

1. *Increment Value Duty.*—This is a duty at the rate of one pound for every complete five pounds on the increment value of any land

accruing after the 30th day of April, 1909, and is payable on three occasions, viz.:—

(*a*) on the occasion of any sale effected, or lease for more than fourteen years entered into, after the commencement of the Act;

(*b*) on the death of any person after the commencement of the Act where the fee simple or interest in the land is property liable to estate duty; and

(*c*) where the land or any interest therein is held by any body corporate or unincorporate in such a manner that the property is not liable to death duties on the periodical occasions provided in the Act, viz. in 1914 and every fifteenth year thereafter.

The duty is only leviable in so far as it has not been paid on any previous occasion. It is not charged in respect of agricultural land while that land has no higher value than its market value at the time for agricultural purposes. The value of the land for sporting rights, or for other purposes dependent on its use as agricultural land, is treated as value for agricultural purposes only, except where the value for any such purpose exceeds the agricultural value. Moreover, the duty is not chargeable on the increment value of any agricultural land which, for twelve months immediately before the occasion on which the duty is to be collected, had been occupied and cultivated by the owner thereof, if the total amount of that land, together with any other land belonging to the same owner, does not exceed 50 ac., and the average total value of the land does not exceed £75 per acre. In addition to the ordinary meaning of the term 'agricultural land', it is by the Act held to include land used as meadow or pasture land or as orchards, or osier or woodland, or for market gardens, nursery ground, or allotments.

Small houses and properties in the occupancy of the owner are exempt, provided the annual value for income-tax purposes does not exceed—

(*a*) in the case of a house in the administrative county of London, forty pounds;

(*b*) in the case of a house in a borough or urban district with a population of fifty thousand or upwards, twenty-six pounds; and

(*c*) in the case of a house elsewhere, sixteen pounds.

Land used for games and recreation is also exempt if held without any view to the payment of any dividend or profit out of the revenue, and if held on an agreement which could not be determined for a period of at least five years.

2. *Reversion Duty.*—This is a duty payable on the value of the benefit accruing to the lessor on the determination of a lease, and is chargeable at the rate of one pound for every complete ten pounds of that value. Certain exemptions from this duty are allowed, and among others it is provided that the duty shall not be chargeable on the determination of the lease of any land which is at the time of the determination agricultural land, nor on the determination of a lease the original term of which did not exceed twenty-one years. No reversion duty is chargeable on the determination of a mining lease.

3. *Undeveloped Land Duty.*—This is an annual duty at the rate of ½*d.* per pound chargeable on the site value of undeveloped land. By the Act, land is deemed to be undeveloped if it has not been developed by the erection of dwelling-houses or buildings for the purposes of any business, trade, or industry other than agriculture (but including glasshouses or greenhouses), or is not otherwise used *bona fide* for any industry other than agriculture. If land having been so developed or used reverts to the condition of undeveloped land owing to the buildings becoming derelict, or the land ceasing to be used for any industry other than agriculture, it shall, on the expiration of one year thereafter, be treated as undeveloped land, until it is again so developed or used. Land which is used for agriculture will, as a rule, be undeveloped land, except where glass- or green-houses have been erected, but the duty is not chargeable in respect of any land where the site value does not exceed £50 per acre, and in the case of agricultural land of which the site value exceeds £50 per acre the duty is only chargeable on the amount whereby the site value exceeds the value of the land for agricultural purposes. If agricultural land at the time of the passing of the Act is held under an agreement made previous to 30th April, 1909, the duty is not chargeable so long as the tenancy continues thereunder or until the earliest date after the commencement of the Act at which the landlord is entitled, by the terms of the agreement, to determine the lease. Moreover, there is exemption from the duty in the case of agricultural land occupied and cultivated by the owner (including the lessee under a lease originally granted for a term of fifty years or more) where the total value of that land together with any other land belonging to the same person does not exceed £500. Where the owner of the land can show that he or his predecessors have incurred expenditure on roads or sewers, he is entitled to have the land treated as developed land to the extent of one acre for every £100 of expenditure, except that this proviso will not apply if ten years have elapsed since the date of the expenditure. Moreover, the duty is not chargeable on public parks or gardens; on the site value of any woodlands, parks, or open spaces to which reasonable access is enjoyed by the public, on land kept vacant in pursuance of a definite scheme for the development of the surrounding land if, in the opinion of the Commissioners, this is reasonably necessary in the interests of the public or in view of the character of the neighbourhood; or on the value of land which is *bona fide* used for the purposes of games or other recreation. It is not chargeable on the site value of land not exceeding an acre in extent occupied along with a dwelling house, or on the site value of gardens or pleasure grounds so occupied, when the site value of the gardens, &c., together with the site value of the house, does not exceed twenty times the annual value of the house and grounds for income-tax purposes. This proviso does not apply to exempt more than five acres.

4. *Mineral Rights Duty.*—This is a duty at the rate of 1*s.* per pound payable annually on the rental value of all rights to work minerals and mineral wayleaves. The rental value is taken to be—

(*a*) where the right to work the minerals is under a mining lease, the rent payable in the last working year;

(*b*) where minerals are being wrought by the proprietor, the sum to be fixed by the Commissioners as equivalent to rent; and

(*c*) in the case of a mineral wayleave, the rent paid by the lessee in the last working year.

The duty is not chargeable in respect of common clay, common brick clay, common brick earth, or sand, chalk, limestone, or gravel. Special provisions are made as to increment value duty and reversion duty in the case of minerals worked or leased, and special rules laid down as to the ascertainment of the capital value, detailed consideration of which would be rather beyond the scope of this article. [D. B.]

Poisons, Sale of.—By the Pharmacy Act, 1868, it is an offence for any person to sell or keep open shop for the sale of poisons unless he is a duly registered pharmaceutical chemist and conforms to the regulations of that Act. By the Poisons and Pharmacy Act, 1908, it is, however, provided that these provisions of the 1868 Act shall not apply in the case of poisonous substances to be used exclusively in agriculture or horticulture for the destruction of insects, fungi, or bacteria, or as sheep dips or weed killers, which are poisonous by reason of their containing arsenic, tobacco, or the alkaloids of tobacco, if the person so keeping open shop is duly licensed for the purpose by a Local Authority and conforms to the regulations laid down by the 1908 Act as to the keeping, transporting, and selling of poisons. Before granting a licence the Local Authority shall take into account whether, in the neighbourhood where the applicant for the licence carries on business, the reasonable requirements of the public, with respect to the purchase of such poisonous substances, are satisfied. The Local Authority for the purposes of the Act shall, in the case of a municipal burgh in England with a population of over ten thousand, be the council of the borough, in the case of a royal, parliamentary, or police burgh in Scotland, be the town council, and as respects any other place be the council of the county.

[D. B.]

Road.—By the Development and Road Improvement Funds Act of 1909 (referred to above in this volume under Agriculture, Development of), it is provided that for the purposes of improving the facilities for road traffic in the United Kingdom and of the administration of the road improvement grant provided under any Act passed in the present or any future session of Parliament, there shall be constituted in accordance with regulations made by the Treasury a Board, to be called the Road Board, consisting of such number of persons appointed by the Treasury as the Treasury may determine. The Treasury has fixed the number of the Board at five, of whom one only is paid. To this Board is entrusted the administration of the road improvement grant, which, by the terms of the Finance Act, 1910, is to consist of a sum equal to the net proceeds of the duties on motor spirit and on licences on motor cars.

Powers of Road Board.—The Road Board shall have power, with the approval of the Treasury

(*a*) to make advances, either by way of grant or by way of loan, or partly in one way and partly in the other, to county councils and other highway authorities in respect of the construction of new roads or the improvement of existing roads,

(*b*) to construct and maintain any new roads;

which appear to the Board to be required for facilitating road traffic. The sum expended by the Board out of income on the construction of new roads or the acquisition of land shall not in any year exceed one-third of the estimated receipts of the Board for that year. The expression 'improvement of roads' includes the widening of any road, the cutting off the corners of any road where land is required to be purchased for that purpose, the levelling of roads, the treatment of a road for mitigating the nuisance of dust, and the doing of any other work in respect of roads beyond ordinary repairs essential to placing a road in a proper state of repair, and the expression 'roads' includes bridges, viaducts, and subways.

Roads constructed by the Board shall be public highways, and all enactments relating to highways and bridges shall apply except that the road shall be maintainable at the cost of the Board, who have in relation thereto all the powers of the county road authorities except the power to levy a rate. Communications between a road or path and a road constructed by the Board shall be made in manner to be approved by the Board. Before the Treasury approve of the construction of a new road by the Board, they shall consult with the Local Government Board and satisfy themselves that notice has been given to every highway authority affected, and shall consider any objections raised by any such authority.

The Board may acquire land for the construction of a new road, and, in addition, land on either side of the proposed road within 220 yd. from the middle of the proposed road. They may also acquire, erect, and furnish such buildings as they may require, and acquire the necessary land therefor. Where they cannot acquire the land on reasonable terms, they may apply to the Development Commissioners for powers of compulsory purchase. It is, however, provided that the powers of compulsory purchase shall not apply to the acquisition of land on either side of a road proposed to be constructed by the Board if the land, at the date of the Order, forms part of any park, garden, or pleasure ground, or forms part of the home farm attached to and usually occupied with a mansion house, or is otherwise required for the amenity or convenience of any dwelling house, or which at that date is the property of any local authority, or has been acquired by any corporation or company for the purposes of a railway, dock, canal, water, or other public undertaking, or is the

site of an ancient monument or other object of archæological interest.

The provision as to commons and open spaces (referred to above in art. AGRICULTURE, DEVELOPMENT OF) does not apply to the acquisition of common land for the purpose of the construction of a new road or the improvement of an existing road within a rural district, but it is provided that nothing in the Act shall authorize the acquisition of land on either side of a new road to be constructed by the Board where the land forms part of a common, open space, or allotment. For the provisions as to the compensation payable for the compulsory acquisition of land, see above in this volume under AGRICULTURE, DEVELOPMENT OF [D B.]

Road, Rule of. — In supplement to the article in vol. x, p. 127, the following dicta of the Lord President of the Court of Session on the duties of drivers on side roads intersecting highways is of considerable interest The case in which these remarks were made was that of a collision between two motor cars one of which was travelling along the main road and the other coming out of a side road, and in the course of his opinion the Lord President made the following observations 'If there is one rule more than another that it is necessary to lay down for the practical conduct of traffic it is, that it is the business of those who are on the cross roads and going to cross the main road to look out when they enter the main road, and to give way to all traffic which is coming along the main road Of course, there is a degree in everything. They have a right to cross the main road, and it does not mean that they are never to get across the main road until nobody else is in sight, but it does mean that where there is any possibility at all of collision it is the business of the person on the side road to give way to the person on the main road; and, as the corollary to that, it means that you ought to approach into a main road from a side road at such a pace as to have your car entirely under control, so as to be prepared for whatever you find is the state of affairs upon the main road.' Of course, these observations will apply equally to horse-drawn vehicles. [D. B.]

Tobacco. (Legal.)—The prohibitions against the cultivation of tobacco in the United Kingdom, and the exportation of the same thence, which for many years existed have been removed by recent legislation, and it is now provided that all the Acts prohibiting the growth of tobacco in the United Kingdom are to be repealed as soon as Parliament has made provision for an excise duty on tobacco grown there. The Commissioners of Inland Revenue are empowered to make, and have now made, regulations, which came into force on 1st March, 1911, prohibiting the cultivation, and the manufacture or preparation of home-grown tobacco, except by persons holding a licence, and on land and premises approved by the Commissioners for the purpose, and regulating the cultivation, manufacture or preparation with a view to the collection of the excise duty The Commissioners are empowered to fix the date of the expiration of a licence, and may refuse to grant a licence for any land or premises on which from their situation with respect to the premises of a manufacturer of tobacco they consider it inexpedient to allow the growing or curing of tobacco. The regulations do not prevent any person from sowing tobacco seed, or supplying or planting tobacco plants solely for botanical, scientific, or ornamental purposes in any nursery or private garden, provided the area sown or planted does not exceed one pole in any one place or garden. [D B.]

Trespass.—The case referred to under the article TRESPASS (vol xi, page 238), in which damages were claimed for injuries done by a savage horse, has since the publication of the article been reversed on appeal by the House of Lords, who held that the owner of the horse owed a duty to the public crossing the field to give notice of probable danger from the horse, and that as he had failed to give such notice he was liable for the injuries caused to the appellant. The reason for the judgment seems to be that although the party injured had no right to be in the field, yet he and other members of the public were there in the knowledge and practically with the permission of the owner of the horse. [D. B.]

TABLE SHOWING VALUES OF VARIOUS FARM FOODS

COMPOSITION, NUTRITIVE AND MANURIAL

Great variations occur in the composition of any particular food, but the following data have been compiled

Food.	Total Percentage in Food: Total Dry Matter	Crude Protein (Albuminoid)	Oil	Soluble Carbohydrate	Crude Fibre	Digestible Percentage in Food: True Protein (Albuminoid)	Oil	Carbohydrate and Fibre	Albuminoid Ratio in Digestible Matter	Starch Value, i.e. Weights of Starch equivalent for fattening Purposes, to 100 lb. of the Food of the composition given. (Kellner)
Cottonseed Cake—Decorticated	92	41	9	26	8	34	8½	20	1 : 1¼	71
,, ,, Undecort., Egyptian	88	22	5¼	34	20	15½	5¼	20	: : 2½	40
,, ,, ,, Bombay	88	20	4½	35	22	14	4	21	: : 2¼	37
Linseed Cake	88	30	10	31	9	25	9½	32	: : 2½	76
Rape Cake	90	32	10	29	11	22	8	24	: : 2½	61
Earthnut Cake Decorticated	89	46	10	23	5	40	9¼	20	1 : 1¼	76
Cocoanut Cake	89	22	10	36	15	17	9½	39	: : 3¼	78
Palm-nut Cake	90	17	10	36	22	14	9½	36	: : 1	62
Soy Bean Cake (Soya Cake)	88	43	7	28	4	34	6½	21	: : 1	82
Soy Bean Meal (Soya Meal), Extracted	88	45	2	30	5	36	1½	21	: :	86
Soy Beans	89	36	17	26	5	28½	15½	20	: :	86
Linseed	91	23	36	23	6	17	34	21	: : 2½	119
Locust Beans	86	6	1½	70	6	3½	1	70	20 : 1	73
Wheat Middlings (Fine Pollards)	88	15	3½	62	5	12	3	56	: : 3½	77
,, Sharps (Coarse Pollards)	88	15	4½	57	8	11	3½	50	: : 3½	68
,, Bran	87	14	4	56	9	10	3	45	: : 3½	57
Oatmeal	90	15	8	60	3	10	7	48	: : 6¾	87
Maize Germ Meal	90	12	11	60	4	8½	10½	35	: : 9½	87
Gluten Meal	90	38	4	45	2	33½	3½	12	1 : 1	76
,, Feed	90	26	3	53	6	21	2½	32	: : 2¼	73
Rice Meal	90	12	12	50	8	6	10	12	: : 11	70
Malt	92	10	2½	68	8	6	2	63	: : 11½	70
Malt Dust or Coombs	90	23½	2	44	12½	11½	1	39	: : 3½	49
Brewers' Grains (Wet)	24	7	1½	12	5	3½	1½	10	: : 3½	15
,, (Dried)	91	19	5½	45	19	12½	5	38	: : 3½	51
Distillers' Grains (Dried)	91	17	5½	50	16	11	5	40	: : 4½	53
Molasses or Treacle (Beet)	78	10	—	60	—	—	—	55		48
,, ,, (Cane)	70	2	—	66	—	—	—	60	—	53
Meat Meal	89	12	13	—	—	67	12½	—		32
Wheat	87	12	2	68	2	9	1½	65	: : 7½	74
Barley	86	10	2	67	5	9	1½	64	: : 9½	73
Oats	87	12	6	57	10	9	5¼	45	: : 6½	63
Rye	87	11½	2	70	2	9	1	65	: : 7½	72
Maize	89	10½	5	70	2	7	4½	68	: : 11½	81
Beans	86	25	1½	48	12	19	1½	48	: : 12½	67
Peas	86	23	1½	54	6	17	1	53	: : 13½	70
Straw Wheat	86	3	1½	37	40	½	½	34	1 : 27½	12
,, Barley	86	3½	1½	38	38	½	½	40	: : 83	19
,, Oat	86	3½	2	33	37	1	½	39	: : 40	19
,, Rye	86	3	1½	33	44	½	½	35	: : 73	11
,, Bean	82	8	1	31	36	3½	½	36	: : 11½	19
,, Pea	86	9	1½	34	35	3½	½	32	: : 9½	15
Meadow Hay	86	10	2½	42	26	4	1	41	: : 11	31
Clover Hay	84	13	2½	37	25	5½	1½	38	: : 7½	31
Pasture Grass	20	3	½	10	5	1½	½	11	: : 8½	12
Clover (Green)	19	3½	½	8	5	2	½	9	: : 5½	10
Vetches (,,)	16	3½	½	6	5	2	½	7	: : 4	8
Lucerne (,,)	24	4½	½	9	7	2	½	9	: : 5½	10
Cabbage	15	2½	½	7	2	1½	½	7	: : 5½	9
Rape	14	2½	½	6	3	1½	½	6	: : 5	8
Turnip Tops	12	2	½	5	2	1	½	5	: 11½	6
Turnips	9½	1	½	6	1	½	½	6	: : 5½	6
Swedes	11½	1½	½	8	1½	½	½	8	: : 3½	7
Mangels	12	1½	½	9	1	½	½	9	: : 2½	7
Carrots	13	1½	½	9½	1½	½	½	10	: : 2½	9
Sugar Beet	25	1½	½	20	2	½	½	20	: : 8½	15
Potatoes	25	2	½	21	1	½	½	19	: : 9½	19
Milk—Cow (Whole)	12½	3½	3½	4½	—	3½	3½	4½	: : 4½	16
,, ,, (Skim)	9½	3½	½	4½	—	3½	½	4½	: : 2½	9
,, ,, (Separated)	9	3½	½	5	—	3½	½	5	: : 1½	8
,, Ewe	20	6½	8	5	—	6	8	5	: : 4	29
,, Mare	9	1½	½	5½	—	1½	½	5½	: : 5	10
Whey	7	1	¼	5	—	—	¼	5	: 5½	6

VALUES OF VARIOUS FARM FOODS

from a number of sources, and must be considered as having reference in each case to *food of average quality*

Food	Manurial Ingredients: Per Ton — Nitrogen *	Per Ton — Phosphoric Acid † (P_2O_5)	Per Ton — Potash (K_2O)	Per Ton — Lime (CaO)	Per Cent — Nitrogen *	Per Cent — Phosphoric Acid † (P_2O_5)	Per Cent — Potash (K_2O)	Per Cent — Lime (CaO)	Estimated Value of Manure produced by Consumption of 1 Ton of the Food allowing half the Nitrogen three quarters of the Phosphoric Acid, and the whole of the Potash (Hall & Voelcker's Method ‡)
	lb	lb	lb	lb	%	%	%	%	£ s d
Cottonseed Cake - Decorticated	155	70	36	7	6·9	3·1	1·6	0·3	2 14 10
,, ,, Undecorticated	80	56	36	7	3·6	2·5	1·6	·3	1 13 7
Linseed Cake	106	38	29	9	4·7	1·7	1·3	·4	1 17 3
Rape Cake	112	45	29	15	5·0	2·0	1·3	·7	1 19 8
Earthnut Cake	168	29	33	4	7·5	1·3	1·5	·2	2 14 0
Cocoanut Cake	76	33	44	11	3·4	1·5	2·0	·5	1 11 10
Palm nut Cake	58	24	11	7	2·6	1·1	·5	·3	1 0 1
Soy Bean Cake (Soya Cake)	154	49	40	6	6·9	2·2	1·8	·3	2 13 6
Soy Bean Meal (Soya Meal), Extracted	161	51	42	6	7·2	2·3	1·9	·3	2 16 0
Soy Beans	128	32	29	4	5·7	1·0	1·3	·2	2 1 8
Linseed	86	32	24	7	3·6	1·4	1·1	·3	1 9 2
Locust Beans	23	11	15	3	1·0	·5	·7	·2	0 3 11
Wheat Middlings (Fine Pollards)	54	31	18	1	2·4	1·4	·8	·05	1 0 9
,, Sharps (Coarse Pollards)	56	58	31	2	2·5	2·6	1·4	1	1 6 6
,, Bran	54	60	33	1	2·4	2·7	1·5	·2	1 6 6
Oatmeal	54	54	33	2	2·4	2·4	1·5	1	1 5 10
Maize Germ Meal	43	20	30	2	1·9	·9	1·3	1	0 18 7
Gluten Meal	136	7	1	1	6·1	·3	·05	·05	1 17 6
,, Feed	94	15	4	2	4·2	·7	·2	1	1 7 7
Rice Meal	42	56	15	2	1·9	2·5	·7	1	0 19 10
Malt	38	18	11	2	1·7	·8	·5	1	0 14 0
Malt Dust or Coombs	85	40	45	4	3·8	1·8	2·0	2	1 11 11
Brewers' Grains (Wet)	18	9	1	2	·8	·4	·05	1	0 5 11
,, ,, (Dried)	67	36	4	9	3·0	1·6	·2	4	1 2 5
Distillers' Grains (Dried)	60	33	4	9	2·7	1·5	·2	4	1 0 11
Molasses	33	1	56	7	1·5	·05	2·5	3	0 19 1
Meat Meal	257	15	2	9	11·5	·7	·1	4	3 11 0
Wheat	40	20	13	1	1·8	·9	·6	·05	0 15 2
Barley	36	18	13	1	1·6	·8	·6	·05	0 13 10
Oats	43	15	17	2	1·9	·7	·5	·1	0 15 0
Rye	40	20	13	1	1·8	·9	·6	·05	0 15 2
Maize	38	13	9	1	1·7	·6	·4	·05	0 13 2
Beans	90	27	29	2	4·0	1·2	1·3	·1	1 11 11
Peas	81	20	22	2	3·6	·9	1·0	·1	1 7 7
Straw—Wheat	10	4	18	4	·45	·2	·8	·2	0 6 4
,, Barley	11	4	24	7	·5	·2	1·1	·3	0 7 10
,, Oat	11	1	33	9	·5	·2	1·5	·4	0 9 6
,, Rye	10	4	20	6	·45	·2	·9	·3	0 6 9
,, Bean	29	7	42	27	1·3	·3	1·9	1·2	0 16 1
,, Pea	31	9	22	36	1·4	·4	1·0	1·6	0 13 4
Meadow Hay	34	9	36	22	1·5	·4	1·6	1·0	0 16 4
Clover Hay	50	13	40	41	2·2	·6	1·8	2·0	1 1 8
Pasture Grass	11	3	13	9	·5	1·5	·6	·4	0 5 9
Clover (Green)	13	3	11	11	·55	1·5	·5	·5	0 5 8
Vetches (,,)	13	3	11	11	·55	1·5	·5	·5	0 5 8
Lucerne (,,)	14	3	9	20	·65	·15	·4	·9	0 5 11
Cabbage	10	3	9	4	·4	·15	·4	·2	0 4 4
Rape	10	3	7	4	·45	·15	·3	·2	0 4 3
Turnip Tops	8	3	4	9	·35	·15	·2	·4	0 3 3
Turnips	4	2	7	1	·2	·1	·3	·05	0 2 7
Swedes	4	2	7	2	·2	·1	·3	·1	0 2 8
Mangels	4	2	11	1	·2	·1	·5	·05	0 3 5
Carrots	4	2	7	3	·2	·1	·3	·1	0 2 7
Sugar Beet	4	2	9	1	·2	·1	·4	·05	0 3 0
Potatoes	7	3	13	1	·3	·15	·6	·05	0 4 6
Cow's Milk—Whole	—	—	—	—	·55	·2	·15	·15	—
,, ,, Skim or Separated ...	—	—	—	—	·5	·2	·2	·15	—
Whey	—	—	—	—	·15	·1	·15	·1	—

* To get approximately the equivalent amounts of Ammonia increase by one-fifth

† ,, ,, ,, ,, Phosphate of Lime multiply by 2¼.

‡ In calculating these manurial values, the unit prices adopted by Hall and Voelcker (Journal of the Royal Agricultural Society, vol lxiii, 1902, p. 108) have been employed, viz —Nitrogen = 12*s* (Ammonia at 9*s* 10½*d*); Phosphoric Acid = 3*s*. (Phosphate of Lime at 1*s* 4½*d*.); Potash = 4*s*. Lime is not taken into account

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